THE ELECTRICAL REVIEW

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ELECTRIC LIGHTING.

THERE is much food for reflection in the paper read by Mr. Gordon before the Society of Arts' meeting last month, which paper is to be found in the pages of our present issue. The first thing to strike a reader unacquainted with the names of the many energetic workers who have laboured unceasingly in the cause of the development of electric lighting is, that Mr. Gordon mainly, and Mr. Edison to a certain extent, have been the sole actors in bringing practical electric lighting to the stage in which we now see it. That such a construction should be put upon his paper is, we are sure, far from being in accordance with Mr. Gordon's nature, and therefore we only take exception to the title of the paper under comment. "To solve the problem for the establishment of electric lighting," says Mr. Gordon, "we must first provide a perfectly steady, perfectly safe and reliable light." The author evidently thinks that his system secures the latter; but he has only to peruse the experiences of the Edison Electric Light Company embodied in the report of Colonel Haywood on the lighting of the Holborn Viaduct, in order to modify his sanguine views. There is a great similarity between the two systems, both use large machines working at slow speed direct from the steam-engine, and both dispense with secondary batteries. Neither Mr. Gordon nor Mr. Edison, as far as we are aware, believe in the use of accumulators, the former probably because his machine gives alternating currents, and the latter, most likely, because he has not yet invented one so good as those already known. In either case, whatever may be the reason, the two gentlemen in question decidedly set their faces against them.

The Edison machines and system generally have been for some time in practical operation both in London and in New York, but we are not aware that Mr. Gordon has yet left the experimental stage. What is the result of a year's work on the Holborn Viaduct? That on five occasions a complete breakdown occurred. While on this point we cannot do better than quote our contemporary the *Engineer*, with whose remarks we entirely agree.

"It will not fail, we hope, to attract our readers' notice that the mere duplication of parts will not suffice to prevent such casualties as we speak of. The Edison Company claim for their installation that it is perfect, and yet it broke down completely five times in a single year. By an awkward concatenation of events, the engine of one set of machinery and the dynamo of the other broke down. The lesson is extremely important. It shows that so long as reliance is placed on mechanism, so long will there be the chance of a breakdown. The way out of the whole difficulty lies, of course, in the use of a storage battery; one competent to keep all the lamps going for a couple of hours appears to be all that is needed, and there is no longer any difficulty in getting such a battery. Mr. Edison is, however, much opposed to the adoption of secondary batteries. Mr. Edison is no doubt a great authority, but he will have to give way to the force of public opinion, or else he will be brushed aside. Absolute certainty of non-extinction is essential to electric lighting on a large scale, and the condition can only be secured by the aid of storage batteries."

Although the advantages of big machines may be great in comparison with small ones, it cannot be denied that it is unwise in the present stage of the development of electric lighting to—using a common phrase—put all our eggs in one basket. Is it not better, in the absence of secondary batteries to use smaller machines and several engines? Mr. Gordon considers it bad policy to greatly cheapen the dynamo, and comes to the conclusion with great ingenuity that it does not matter if the dynamos are a little cheaper and the engines *dearer* so long as the total sum for the whole installation remains the same. By what course of reasoning he assumes that cheapening dynamos should render engines more expensive we do not pretend to explain, but we think that the cheaper a machine of the Gordon type can be offered at, the better for the future of the Gordon machine, for it most certainly forms a considerable item in the total expenditure.

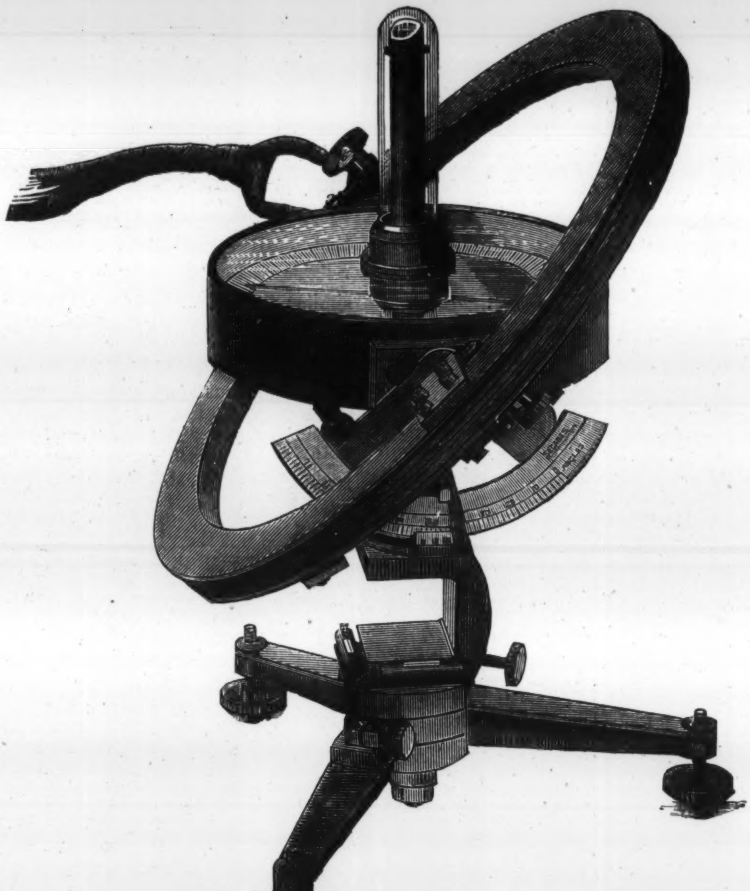
There will doubtless be plenty of employment at no distant time for electric lighting systems in extending and adding to the isolated installations already put up; but it is evident that electric light companies, to render their systems as reliable as our old servant Gas, must adopt a somewhat similar method of working, that is to say, some arrangements must be made so as to produce during the day that which—or its equivalent—is to be used during the night. The only means known to us for doing this is by the employment of storage batteries, and it is not a little curious to note that the two inventors, whose operations so far have been of the most extensive nature, discard this useful adjunct towards giving us a light the occasional extinction of which we should not then be in constant fear.

We do not see the possibility of either Mr. Gordon or Mr. Edison ever being in the position to insure to us the reliability of gas as long as they depend on their present systems of operation, and we will here again quote our contemporary. "We may point out that so long as it remains possible for a large public building as a theatre, a church, or an hotel, to be left in darkness for even three minutes, so long must the electric light be excluded from such structures. The failure of the lights in a theatre might produce a panic, followed by the most disastrous results. It is time that electricians recognised this truth and seriously addressed themselves to overcoming a difficulty which is in no sense or way insurmountable. No amount of excuse or apology will do. It must not be admitted for a moment that because the light only failed for even a single minute that little harm was done. When lights go out in this way no one can tell whether there may be a delay of a minute or an hour in re-lighting them. If such interruptions were really unavoidable, then would the fate of the electric light be sealed; and this truth ought to be insisted on by every engineer and committee in an influential position."

The discussion which followed the reading of Mr. Gordon's long paper will be found of an interesting character, particularly the remarks of Mr. George Offor and those of Mr. C. Godfrey Gümpel. Mr. Gordon has our best wishes for the success of his schemes, and were only energy and enthusiasm needed then success would be already insured.

DR. EUGEN OBACH'S IMPROVED GALVANOMETER.

THE instrument here illustrated is an improved construction of the movable coil galvanometer for determining current strength and electromotive force in absolute measure. The tangent galvanometer with its coil movable around a horizontal axis, designed some time ago by Dr. Obach and constructed by Messrs. Siemens Bros. & Co., has lately undergone several improvements. It is now equally suitable for accurately measuring current strength and electromotive force. For this purpose it has a grooved gun metal ring on which a coil of German silver wire is wound. The number of convolutions and the resistance of the coil are so chosen that the E.M.F. of one volt exactly produces the same deflection with the fine wire coil as the current of one ampère with the solid ring. This simple relation is very convenient for calibrating the galvanometer by the aid of a few cells of known E.M.F. simultaneously in volts and ampères. Experiments give closely agreeing values for the "*constant*" when determined either with the ring or the coil.



For currents exceeding 50 ampères, the galvanometer can be provided with a "*constant shunt*" consisting of two or three little bridge-pieces left standing in the open part of the ring. Currents are led to the instrument by means of a flexible cable perfectly inactive upon magnetic needles and therefore termed an "*adynamic lead.*"

The change of the "*constant*" when the instrument is taken from one place to another is avoided by a compensating magnet placed E. or W. from the needle and parallel to the meridian. This magnet can be turned on a horizontal axis passing through its centre and through that of the needle; it is entirely inactive if vertical, whereas it acts upon the needle, if it is more or less dipped, without, however, interfering with the zero position. By giving the magnet a proper dip the constant can always be kept at the *same value.**

The needle is fixed to a thin vertical axle suspended by means of a cocoon fibre and weighted at the lower end, it is therefore not subject to dipping. The swing can be obtained perfectly dead beat by means of an adjustable air damping. One half of the scale on which the deflections are read bears tangent divisions, and the vertical scale showing the position of the coil has, in addition to the usual degrees, a number of marks engraved upon it which correspond to natural "*secants.*" With either one of these secants, according to the position of the coil, the tangents of the deflections must be multiplied, and consequently they may be termed "*multiplying powers.*"

Several series of measurements have shown the high degree of accuracy which can be obtained with the galvanometer. A smaller and somewhat less elaborate instrument than the one described is in course of construction which also includes the latest improvements and is intended for daily requirements.

The *movable coil galvanometer* offers several advantages over other measuring instruments proposed for similar purposes; for instance, it does not depend upon the constancy of permanent magnets or of springs, which is always precarious; nor has the needle to be shifted for measuring different current strengths or E.M.F.'s, a procedure by which the magnetic field mostly changes.

It does not require *variable shunts*, which, when dealing with small resistances, only too easily introduce errors. Another important point is that each particular current strength or E.M.F. can be measured at several positions of the coil. The mean of a number of such measurements then gives the result with still greater accuracy.

If in addition the constant is taken at the beginning and at the end of each series of experiments the trustworthiness of the absolute values is greatly enhanced.

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* The compensating magnet is not shown in the illustration.

HETT'S PATENT TRENT TURBINE.

A CONSIDERABLE amount of attention is now being paid to the production of means for utilising water-power in connection with dynamo-electric machines, and engineers are now engaged in designing special machinery for this purpose.

Mr. Charles Hett has brought out a turbine arranged for high falls, and for utilising a large amount of water, and specially devised with a view to employment for permanent electric lighting. From information supplied to us by that gentleman we are enabled to give our readers a short description of this apparatus, which might otherwise escape the notice of those not engaged in the more mechanical departments of electric light engineering.

It is very strongly constructed in every part, and the description of the wheel proper is as follows: The buckets are of steel pressed into proper shape, and cast into the wheel, these are very much superior to the ordinary form of bucket, which are of cast-iron made in one piece with the wheel, and they possess the advantage of greater strength and durability; more power can also, it is said, be obtained by the use of these than by the ordinary kind.

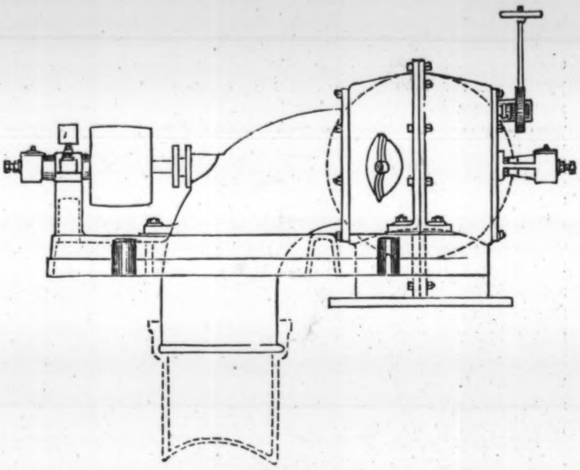

FIG. 1.

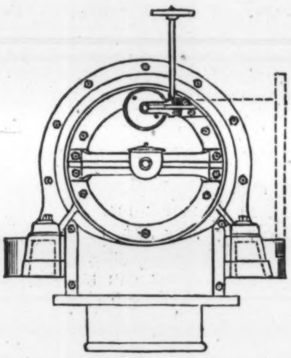

FIG. 2.

The spindle of the turbine is of steel 3½ in. in diameter, turned from end to end, which, for convenience in shipment, is constructed in three pieces, joined by suitable turned flange-couplings. The shaft is carried by improved "Universal" adjustable bridge bearings securely bolted to the two wrought-iron girders to which the case of the turbine is also fastened. End adjustment is also provided to compensate for wear, by which means the wheel can be set up and retained in position to a nicety.

The case is provided with a man-hole at the top for access to the wheel inside, as well as with an end cover, which can be removed, and the wheel, &c., entirely withdrawn without disturbing or breaking a single pipe-connection, which is a point of great desirability well-known to mechanical engineers. The whole of the arrangement is carried on two wrought-iron girders 24′ 0″ long × 14″ deep × 6″ wide, which can be bolted down on the level or built into walls as most convenient.

To insure uniform speed, the turbine is provided with improved automatic governors, with all the latest improvements suggested by experience. These are driven by a strap direct from the shaft of the turbine, and are provided with a hand-regulating arrangement for stopping and starting the turbine.

Figs. 1, 2, and 3 represent a 12″ electric light turbine, similar in construction to the 24″ machine just described, but mounted on a cast-iron bed-plate, and simplified as much as possible and perfectly self-contained. The inlet branch can be placed in any position desired. The turbine requires no foundation, and can be bolted down to beams or even to a wall if necessary. In the latter case the arrangement of the draft tube is varied to suit the position. Perfect accessibility is observed in the construction of this class of turbine, as well as in the 24″ already mentioned, and it is more suitable for smaller quantities of water. Turbines from 16″ downwards are made in this form.

For very low falls the arrangement shown in fig. 4 is a convenient one. It will be seen that in this case the turbine is placed open in a well, and the water admitted all round it. This is a very cheap and efficient method of setting where applicable, and the water needs only shutting off at the intake for access to be made to the wheel. The tail-water is carried away either by an open race or conduit, whichever is the more convenient.

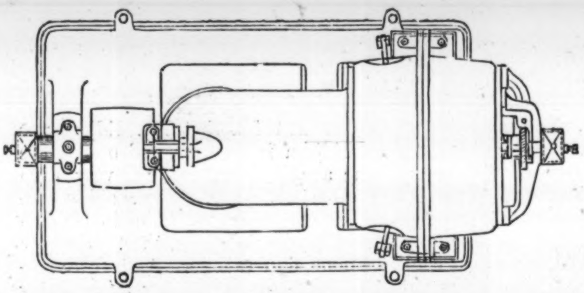

FIG. 3.

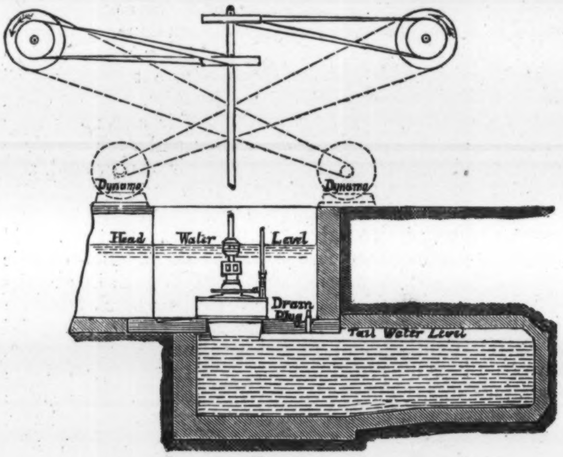

FIG. 4.

Particular attention should be observed with setting of turbines that the draft-tube in every case dips into the tail-water, otherwise a certain amount of power may be lost.

There are numerous methods of fixing wheels; but those described are the ones most generally adopted.

The Telephone in Europe.—We read in the *Electrical World* of New York that American telephone men returning from Europe say they have reasons to know that the governments of Belgium, France, and England contemplate purchasing the telephone patents for their respective countries. This is news as far as we in England are concerned.

THE DEVELOPMENT OF ELECTRIC LIGHTING.[*]

By J. E. H. GORDON, B.A.

AMONG all the great industries which in this wonderful last fifty years have been developed, there is none, perhaps, that has had so stormy a birth as the industry which we have met to speak of to-night, namely, that of electric lighting. We must remember that the public know very little indeed about electricity, in fact, nothing. Even in the early days of railways, although there was much ignorance about steam, still everybody had seen a kettle boiling, and had some vague idea of what steam might be, even if he did not know what it could do. But the public do not know what electricity is, nor have they any knowledge of its laws; therefore, at one time, they were ready to believe any statements made to them about electricity. Nothing was too extravagant, too startling, or too ridiculous for the public to believe in the early days of electrical enterprise. We all remember that panic in gas shares, which occurred about three years ago, when numbers of the public rushed to their brokers, and directed them to sell their gas shares at any sacrifice, to throw them away if there was any liability on them even, but to get rid of them. Why? Because a telegram had come across the Atlantic that Mr. Edison said he had made a discovery which would supersede gas.

You must not for a moment think that Mr. Edison was to blame for this. Mr. Edison is a genius, and one of the greatest inventors of the age, and he has, in a very high degree, that poetic and prophetic insight which is able to see beyond the trammels of difficulty; and to know in his own mind, for certain, what will come in the future. He saw that the thing could be done, and said so. And, further—it is, perhaps, a failing of inventors, and being an inventor myself I may say it—Mr. Edison, like all inventors, has that enthusiastic imaginative temperament which is necessary for the development of inventive skill, and possibly he may sometimes have slightly confused what he was certain shortly would be done with what had already been done.

Now, this development of electric lighting has suffered to some extent from its enemies, but of course it is understood that gas shareholders are its natural enemies, and will do all they can to retard it; it is perfectly fair and right they should do so. We regard them as fair and open enemies; we are quite willing to fight them on their own ground, and hope the best man will win. But they have not done us much harm—in fact they have done us good. If there had been no other light to fight against, electric lighting would not have developed as fast as it has done. But electric lighting has suffered terribly, not so much from its enemies as from pretended friends. It has suffered much from the operations of persons who, while professing to be interested in electric lighting, and to desire to hasten its adoption, have only been interested in the progress of Stock Exchange operations, and the formation of bubble companies. I hope the ground is now cleared, and that these bubble companies, having satisfied their promoters, are disappearing, and making way for honest, legitimate enterprise to go on.

Now to turn to the more practical and the more important part of our subject, we have to think what is the problem which has to be solved in the establishment of electric lighting; it is, first, to provide a perfectly steady, perfectly safe and reliable light; and what is very important still, but which is second, to provide that light cheaply. It is no use getting a light a little cheaper than another, if it is to go out or to blink. Our first consideration must be to make the light perfect; the second, following closely, but still second, must be to make it cheap. This problem must be regarded as a whole, I mean the problem of making it perfect. It has been attacked too much in detail, and the reason of that is that, for success in electric lighting, the knowledge of several branches of science is required, which are not often united in the same person; an electrician, for instance, is very often not a first-class engineer. It is no use getting a little more out of your dynamo if that dynamo will not fit the engine; if you have a certain dynamo that works conveniently with your engine, it is no use making the dynamo one or two per cent. better if the alteration causes you to lose ten per cent. more in transmitting power to it. You must regard the engines, dynamos, mains, &c., all as one complete system, and you must remember that if anything goes wrong, the public will not make excuses for the lamps like we may make in the laboratory. They will not say it was not the dynamo's fault, but it was the engine's fault, or the boiler's fault. All that the public would be concerned with was that on this or that occasion the light went out. Therefore we must not despise anything, however foreign it seems to our subject, if it will help to make the system, regarded as a whole, perfect. The pure electrician knows very well that the principle of a dynamo is to move a coil of wire through a magnetic field. Then some outsider says, "How are you going to secure it, and attach it, and support it?" "Oh," he says, "any practical man can tell you that;" but I am afraid that when "any practical man" has found out that, he is apt to patent it and keep it to himself, and sometimes he says that what the electrician has given him is the very smallest part of the invention. Perfecting dynamos is an engineering problem, quite as much or more than an electrical problem.

We must not spend time in going into the details of electric machines, but there are one or two points I may be pardoned for alluding to. It is bad policy to cheapen your system by endeavouring to greatly cheapen the dynamo. The contract price to be paid by a company for electric lighting plant will be one sum for engines, boilers, dynamos, mains, buildings, &c., and it does not matter if the dynamos are a little cheaper, and the engines dearer, so long as the total sum remains the same. But whatever else we economise in we must not economise in the dynamo, for this reason, that the cost of the dynamo is comparatively a small fraction of the cost of the plant, but the dynamo is the very vital heart and lungs of the whole affair. If anything is wrong with the dynamo, it is no use having the most perfect engines and the most perfect lamps, the lights will go out. Therefore the dynamos must be perfect, and any economy, any extreme cheapness that is required, must be achieved in some other part of the plant.

Now, this question brings us to a controversy which has been going on, and has been universally discussed ever since electric lighting was first heard of, and which I think will continue to go on for some time, that is, the controversy between the relative merits of high speed and low-speed dynamos. It is necessary in a dynamo that the coil of armature wire should pass at a certain speed through the magnetic field, and that speed can be obtained in two ways; the wire is wound upon a wheel, and you can either have a small wheel which revolves many times a minute, or a big wheel revolving few times a minute, and you get the same speed of the rim in each case. The controversy between high and low-speed dynamos means this: will you have a small wheel revolving very fast, or a big wheel revolving very slowly? The first and natural opinion is have a small wheel revolving fast, for you can make the dynamo a good deal cheaper that way; it takes up less space, and altogether seems more convenient. I think every one, when he begins electric lighting work, approves of high-speed machines. I did, myself, at one time, very strongly; in fact, less than two years ago, I wrote an article in the *Quarterly Review*, in which, if I recollect rightly, I said the dynamos of the future "will, we believe, revolve much more rapidly than at present; their speed will only be limited by their tendency to fly to pieces." Then my friends and I set to work to build a dynamo on the principles I had laid down in the *Quarterly Review* article. We soon found that in a large high-speed machine there was a great deal of difficulty in getting the power into it at all. You had to put belts to it, in fact a number of belts and counter-shafts, and there was always a good deal of slipping. Then the belts going at high speed used to make a most terrible noise; there was a deafening roar in the dynamo-room, and the whole building used to shake. All these things were bad in themselves, but they were worse in this respect, that all these vibrations, whether of air forming sound, or of the building itself, required mechanical force to produce them, and every bit of that force was stolen from the steam-engine, and taken away from the force that ought to be used in producing light. I suppose this ought to have convinced me that high-speed machines were wrong, but it did not. We went on, we tried a machine, it worked very nicely, indeed, for an hour, and we got excellent electric results, and were very pleased. Then certain vibrations began to get worse, and I thought it advisable to send the workmen away. There was one safe spot where the person attending the machine could stand, from which I was able to watch what happened. The experiment was conducted in a cellar at Wharf Road, all vaulted with brickwork backed by the earth of the street, and it was so hard that when, on some occasion, we wanted to put a spike into it, we were unable to penetrate it all. After a few hours' work the dynamo flew to pieces with a loud explosion, and I have here some of the few fragments that were left of it. Here you can see the fracture of a massive piece of iron that was caught by it; here are portions of the holders of the revolving magnets. I have not much of it here, the rest of it was picked up in a shovel. The only large piece which was found was a piece which weighed 1½ cwt., which struck the hard wall of the cellar (the distance from the dynamo being about twenty-five feet), and cut a hole two feet in diameter and two feet deep. Another piece skimmed along the vaulted roof, and made a series of grooves in which you could put your two fists. After that experiment we thought we had had nearly enough of high-speed dynamos—in fact, we thought we had nearly enough of dynamos altogether. After this explosion, when it might have been fairly thought the whole attempt was at an end, my friends met, almost among the ruins of the dynamo, and in a few days they subscribed a large sum of money, and said to me, "Go on; build us another dynamo ten times as large as the first, only," they said, "make it strong enough this time." We set to work and built a second machine, and this time we went on very different lines. We made the wheel enormous, and made it run very slowly, taking good care that the whole thing was strong enough. The first machines had taken two to two and a-half years to make, the second machine took about eight months, and this was last year; and the experiments cost a great deal of money; one thousand pounds went after another, and still there was no result. Things seemed far from completion, and the money which had been handed to me to build the machine was spent three times over before the machine was finished; still my friends said "Go on, if it costs three times as much as you expected, you must make it do three times as much work." At last we were all ready to try the experiment, and for the last week or ten days I may say we had given up going to bed; it was of no use, for we could not sleep, we used to go to bed for two or three hours, but we spent nearly all night in the factory. At last my friend, Mr. Clifford, the Telegraph Construction Company's chief engineer and myself, began the final trial; we began on the Saturday morning, and thought we should be ready to start the engines on Saturday night; we got the steam up, but first one hitch occurred, and then another, before we could start, and at last it was three o'clock on Sunday morning before we made our first trial. That failed completely, the machine did nothing; we looked over it, and saw what was possibly the cause of error, and set to work to change the connections. Now, if you are changing connections in little dynamos, it is simply a matter of unscrewing two or three screws and changing the wires, but with this large machine, it was not so simple; it took as many men as could cluster over it until six o'clock in the morning; then we got a little better result, and went home for a few hours' sleep. We started again early on Monday morning, and at nine o'clock on the Monday evening we were ready for the trial. The experiments were made at the Telegraph Construction Company's Works, at Greenwich, works which are about a third of a mile long, and cover fourteen acres; there are 1,200 or 1,400 lights all over the works, and as the cable department was then busy, there were about 1,000 men at work, and a little glimmering gas light over each lathe. When I turned the valve the whole place burst into a blaze of daylight at once, and we felt at last rewarded for that three years of anxiety we had had before.

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[*] Paper read before the Society of Arts, May 24th, 1883.

Now, what are the chief advantages of a big machine as compared with a small one? I think the chief advantage of all is that we can dispense with belts. With a big machine we get the necessary velocity by the largeness of the wheel, and, therefore, can cause it to revolve only the number of times in a minute which is not too great for the steam-engine to revolve, and can connect direct to the steam-engine. Mr. Edison was the first to point out the importance of this, and his was the first very large machine which was made. He has constructed a very large dynamo, which works 1,300 of his lamps, equal to about 1,000 20-candle lamps, his being 16-candle. It has been worked extremely successfully in New York and also in Holborn. Now I will show you some of the important points, not of dynamos generally, but of a large machine as compared to a small one.

I come to a very important point, which is where the current is taken off. Of course, if a current has to be taken from a moving coil to fixed wires such as the conductors that go to the streets, there must be sliding or rubbing contact of some sort, and you have all seen in ordinary dynamos the contact brush or commutator, and there is always a little sparking. As the current gets greater, that sparking gets not proportionately, but still it is greater when you get a large machine. I must say myself I think the current for 1,000 or 2,000 lights is about the biggest that can be taken off by rubbing contact, but I never heard that with this 1,300-light machine there has been any difficulty with this. Still, as a matter of prudence, I should not consider it advisable to take enormous currents through rubbing contacts. I am speaking of currents which will supply as many lamps as come from our big gas works. Therefore, when we designed this machine I have been speaking of, we arranged it somewhat differently. We used an arrangement which is not new, but was never applied on a large scale before, namely, causing the magnets to revolve, and the coils to be fixed. That enables the current, however great, to be taken off without sparking at all, there being a metallic connection the whole way from the fixed coils to the mains.

Our machine has been worked up to nearly 2,000 lights, and we were able to get this off a fraction of the coils, and we have no doubt it will give about 5,000 lights with adequate engine-power. We call these 5,000 lights the baby ones; there will be much bigger ones made some day, we hope. There are 32 magnets, which revolve between fixed coils whence the current is taken off. I must be pardoned in my illustration of big machines for going so much into the details of my own, and so little into the details of the excellent machines of Mr. Edison. My excuse must be, first of all, I am not so well acquainted with the details of Mr. Edison's as with my own; and, secondly, from the natural feeling a parent has for his own child, for he always believes it to be the finest child in the world.

We now come to a requirement which is common to all large machines, namely, a method of adjusting and regulating them while they are going. You see we have to keep the pressure constant, and we have a varying demand. We put on a number of lights when we start, and then somebody turns out a number of lights; later on, somebody else turns a number on, and we have to keep the pressure absolutely constant. Now, with any machine, such as this, if a thousand lights, say, are on, and another 500 are put on, the pressure will drop, and the 1,500 lights would not be in proportion so bright as the former 1,000. Similarly, if 500 are taken off, the remaining ones would get brighter, and break the lamps; and, therefore, means for compensating for these changes have to be provided. The way in which the regulation is done is by varying the strength of the field-magnets. These magnets, which are fixed on the big revolving wheel, are not permanent magnets, but are magnetised by the current of a small direct current machine. This small direct current machine is driven by a small separate steam-engine, and by varying the speed of this small steam-engine, we can vary the strength of the current in the magnets, and so we can alter the pressure just as we want it. Of course we have to alter the pressure according to the requirements of the district, and this is the way the regulation is at present done. First of all, we have to see what pressure is right, and for that purpose we employ a photometer, an iron rod which casts two shadows on a screen, one the shadow from a candle and the other the shadow from an electric light further back, the relative distances being so adjusted that the candle-power of the lamp is correct at the moment that the two shadows are equal. By shifting the position of the candle we can work to any candle-power we prefer. The lamp employed being a fair sample lamp, we know that if that lamp is right all the others are right, but we have one or two connected from different parts of the factory, which can be turned on by means of switches. Now, suppose some one at the other end of the factory turns off 100 lights, when there are a large number on, that would not be perceptible in the factory; but the man here can see the change of brightness much more readily than any one can in the open room or yard, and he at once sees that the pressure has run up a little bit. He then turns a valve a little, which partly shuts the tap, and diminishes the supply of steam to the small engine, that diminishes the speed and the strength of the magnets, and so takes the pressure down as required. Similarly, if 100 lamps are put on, he finds the brightness drops, and he has to open the valve and make his small engine run faster. There is one very important feature which it has been necessary to put into this regulating apparatus, and that is due to the property of the human eye to accommodate itself gradually to changes of light. The pupil of the eye expands and contracts, and takes in pretty nearly the same quantity of light, if the illumination is within certain limits. Although the eye is very sensitive to sudden changes of light, yet if you make the change sufficiently slowly, you allow the pupil time to expand or contract, and the change is not noticed very well. Therefore, instead of turning this valve rapidly, it is turned by a slow screw, so that it takes at least a minute to make a change of light equal to one candle-power. The result is that, even if a considerable change has to be made, such a change is never noticed at all. There is a steam-pressure gauge, showing the pressure on the boiler, and an indicator showing the speed of the large engine, and two men stand here on duty, in turns, all night, to work the valve.

You may say that this is an expensive way of regulation, on account of the cost of men's wages; but what we have to consider in the commercial aspect of electric lighting is not the price of working each machine; but the price of working each lamp. It would have been ruinously expensive to have one or two men to attend to a small machine, but when their wages are distributed between 5,000 or 15,000 lamps, it becomes a very small item of expense indeed, although those same wages distributed between 500 or 1,000 would be very extravagant.

There is one small point about this machine, before we leave the technical part of the subject, which I may be pardoned for mentioning; although it is a purely scientific point, I think it is of some general interest, as showing the kind of difficulties which the designer of any new engineering work has to encounter. In our first model machine we made the same number of coils as there were magnets; that is to say, there were a series of round bobbins in that disc of the machine, and a similar number on the revolving wheel, and currents were induced in the way usual in that class of machine. On the first experiment we put one coil on the small experimental machine, and got a good result, but when we put on the next coil alongside, we found the mutual action of the two coils pulled down the amount of light produced nearly 50 per cent., in fact, diminished the power of the machine nearly one half. A little study of the laws of induction will show you how that occurred. It is a well-known law that a varying current, under certain circumstances, will induce a current in an opposite direction to itself. Here was a current travelling in one direction, which induced a current in the opposite direction, in a neighbouring coil, so that we got two opposite currents, and we only got the difference between the actual current induced by the magnet and the back current induced by the next coil. The practical result was that the efficient lighting we got out of the machine was reduced to about one-half. To get over the difficulty we made the number of fixed coils twice the number of the magnetic poles, flattened them, and squeezed them together, so that each pair of coils was acted on alternately, and between each there was a coil which was not in use at the moment; therefore, although there was a tendency to induce back currents, yet each pair of active coils being separated by an intervening coil, the action was so small as not to be perceptible, and thus the quantity of electricity we could get out of the machines was nearly doubled.[*] We hoped we had now got the dynamo perfect, and that we had solved the problem, and got to the end of our troubles. We had got the dynamo as perfect as we knew how, but we found our troubles only beginning. It is a small portion of the problem of electric lighting to get the dynamo perfect, because there are so many details to be attended to. In putting up a plant for 10,000 lights, in the middle of a populous town —a town of wealthy houses, where the inhabitants do not at all like smoke and waste steam—there are a great many matters to be attended to. On a diagram I have shown a plant for an installation for 10,000 lights, which we hope to have the opportunity of putting up soon. This is not the only way, perhaps, not the best way in which it could be worked out, but it is one way which has commended itself to us. Of course, we have to get our boilers in pretty close; there are seven boilers here. Then there is the dynamo house with three dynamos, each working 5,000 lights, two to be always at work, and one in reserve, the whole plant being designed for 10,000. Then we have an arrangement so that the mains are laid double. That is to say, each house has half its lights from one dynamo, and half from another, so that, supposing an earthquake upset one of the dynamos and put it wrong, then only half the lights would go out; the town would not be put in darkness. There is one class of accident which may occur to any machine, and it is, I think, about the only difficulty which large dynamos are liable to, that is getting a hot bearing. But an engine driver is not worth his wages if he cannot keep an engine with a hot bearing going for a quarter of an hour, and supposing he finds he has a hot bearing, all he has to do is to start the spare dynamo, get the speed of that the same as the speed on the other, start the exciting engines, get the pressures constant, then pull over the switch, and all that will happen will be a slight jump in the light, and then the engineer may instantly stop the heated dynamo and attend to the bearing. The engines are condensing engines, each dynamo to have two, and they will require about 510 indicated horse-power when at full work. Each engine is calculated to have a power of 275 indicated horse-power, so as to give about 550 horse-power available, which is sufficient reserve. Again, there are boilers in reserve; 4½ boilers would give sufficient power, so that there will be always two boilers standing quite idle, which can be cleaned. There would be a large crane running along the roof, which we used to put the machinery into its place, and to lift any part of it as may be required for repairs.

As to the space required, these engine-houses for a 10,000 light plant, require 72 feet square; that is to say, two strips, 72 feet by 36 feet. If it were more convenient for the site, we might set the boiler-house end to end with the engine-house. Then we have to get a supply of coals. We cannot put the coals on with a shovel when working on this scale. We have to think of bringing the coals in through a populous neighbourhood, storing them so as not to cause a nuisance, and feeding them so as not to cause smoke, and also so as not to have an enormous staff of firemen, whose wages would run away with our profits. We may assume at once that we must have what are called mechanical stokers to the boilers; that is to say, that each furnace is fed not by shovelling in coals but by a little steam apparatus, by which the coal is discharged into a hopper and slowly screwed into the furnace. That has the advantage that it enables us to burn much cheaper coal than we could otherwise do. We have here a coal store, which will hold about three weeks' winter supply, so that we need only coal about once a fortnight, and we can do it at night. The floor of this coal store is higher than the level of the boilers. The coal waggons will stop outside; there is a small crane by which the sacks are all taken up; the coal is emptied into the store until it is full, and that is the only time the coal is lifted. Near the bottom of the coal store there is a trap-door, and the coal comes out and is run into trucks running on a raised tramway, and is discharged by its own weight into the hoppers of the stokers. There is, again, a second underground tramway for removing the ashes, so that the coal requires no handling at all.

You may say this is all very pretty; it is a very nice dream for the future, but what is it going to cost? People are not going to buy electric light at two or three times the cost of gas. That is a very important question, and he would be a very bold man who would speak too strongly on the subject; but yet I think we may say, not that electric lighting will be dearer than gas, but that it will be almost immediately cheaper. I believe that in the future it will be about two-thirds the price of gas; and I am quite certain that at present it can be supplied in London at the same price as gas, when supplied on a moderately large scale. I have worked some estimates of the capital expenditure and the working cost for an electric lighting plant, and there is not much difficulty in getting out the total expenditure accurately. The doubtful point is what the revenues will be. The estimates show the expenditure of capital and the annual expenses for electric lighting plant of two sizes, one for the supply of electricity to 60,000 lamps of 20 candle-power and the other to 10,000 lamps. In each case we can always count upon putting up half as many more lamps as we should supply, for never more than two-thirds of the total number would be alight at the same instant. First comes the capital expenditure, viz., the price which would be charged by the manufacturers for the whole plant, that is, for machines, dynamos, mains, chimneys, and, in fact, bringing a pair of poles into every house, and starting the concern. Those are not estimated sums; they are taken from tenders which my company has actually furnished to corporations, so we know that the expenditure would not exceed those prices, because we have actually offered to contract to do it for the terms mentioned. The annual expenditure is another matter. It depends to a great extent on the number of hours per annum the lights are burning. I have spoken here of 2,000 hours, but I find there has been a good deal of misunderstanding about what is meant by that. I do not mean that all the lights will burn for 2,000 hours, but what I mean is, that the average of the maximum number of lights burning at once will be about 2,000 hours. For instance, suppose in any particular house we put up 30 lamps; there are not, as a rule, more than 18 lamps burning at once, and I should not call the expenditure of that house 30 times 2,000 hours, but only 18 times 2,000 hours. We need not provide, in plant, more than sufficient for the total number of lamps likely to be burning at once. I was talking to a gas engineer the other day, of very great experience, and he thought I might count on never having more than half the lamps alight at once, but, to be on the safer side, I have taken it at two-thirds. The number of hours lamps burn depends where they are. Street lamps burn nearly 4,000 hours; then come clubs, which burn over 2,000, but in private houses they would burn less. I think, with that reservation, that when we are speaking of the maximum number alight at once, and not of the maximum number put up, we may say that 2,000 hours is not very far wrong. Here is the way the expenditure is calculated. Every year put aside something for depreciation. Of course the first year there would be nothing spent, and perhaps not for a few years, but some day new boilers will be required, and for that we should go on the reserve fund; therefore each year a certain sum must be put aside for repairs. I have taken that at about £1,500—a certain percentage on one part of the plant, and a different percentage on another. It is a large percentage on the boilers, a smaller percentage on the dynamos, a smaller still on the mains, and a smaller still on the buildings. When the dynamos are run at a small speed, you can diminish the depreciation on dynamos and buildings; high-speed dynamos shake buildings to pieces before very long. Then comes slack coal at 11s. The consumption of coal has not been guessed at, but is taken by me from figures furnished by Mr. Hill, chief engineer at the Royal Mint. They have lately had a pair of engines put up by Messrs. Maudsley and Field, of 500 horse-power, about the type of engine we think of using. They are not put up for electric lighting purposes, but for driving the machinery of the Mint; they have been working seven or eight months, and the figures for the consumption of coal are from the actual bills. By using mechanical stokers, we can use slack coal at 11s., instead of steam coal at 18s. Mechanical stokers do not give us quite an advantage in the ratio of 11 to 18, because 1 lb. of slack coal does not produce so much steam as 1 lb. of good coal, but still there is a very great saving in using slack—about 13 to 18. The actual consumption at the Mint has been 2¼ lbs. of slack coal per indicated horse-power per hour. From that 11s. that item is taken of £1,230. Then there is the water for condensing purposes. Where we get waterside premises, that will cost nothing; but in central stations we must reckon 6d. per 1,000 gallons, and a rough and ready rule is, that the water costs about the same as the coal when you have to pay for it; and, therefore, I have put it at the same price. Then oil is a small item; wages and superintendence includes the chief electrician, chief engineer, and various workmen required for small repairs. It does not include any large repairs, which are included in the first item. To be in the dark room, and attend to each engine and dynamo, requires three men always in attendance, *i.e.*, one engine-driver, one labourer, and one man in the dark room; each of those work eight hours, so that you require three shifts of men. That makes a man's work 56 hours a week, 54 being the ordinary workman's time. They work, of course, seven days a week. Then there is rent and taxes, interest, directors' fees, and renewal of lamps. These must be renewed free of expense, that is, the expense of renewing them must be included in the charge for electricity, whatever it is. I do not mean if the glass of the lamp is broken it is to be renewed; but when a lamp has been destroyed by the current, it is to be renewed. When the lamp is broken by the current, the carbon alone breaks, not the glass, and the rule will be when the lamp has broken down, but the glass is intact, it can be exchanged without charge for a new one; but if the glass is broken, it follows it is broken by violence, and must be paid for. The total required revenue, including 10 per cent. dividend, you see is £14,928.

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[*] See ELECTRICAL REVIEW for October 28th, 1882.

PLANT TO SUPPLY ELECTRICITY SIMULTANEOUSLY TO 60,000 LAMPS OF 20 CANDLE-POWER EACH, EQUAL TO 85,000 OF 14 CANDLES. CAPITAL EXPENDITURE, £220,000.

Annual Expenditure, lamps burning 2,000 *hours per annum.*

Depreciation and repairs	£8,000
Slack coal, at 11s....	7,100
Water, at 6d. per 1,000 gallons	7,100
Oil, &c.	850
Wages and superintendence (63 persons) ...	5,390
Rent, rates, and taxes	1,000
Office expenses	500
Directors' fees	1,000
Renewal of incandescent lamps	12,000
10 per cent. of dividend on capital	22,000
Total required revenue	£64,940

85,000 14-candle gas burners burn in 2,000 hours 850,000,000 cubic feet, which would produce £65,000 at 1s. 6¼d. per 1,000 cubic feet.

PLANT TO SUPPLY ELECTRICITY SIMULTANEOUSLY TO 10,000 LAMPS OF 20 CANDLE-POWER EACH, EQUAL TO 14,000 OF 14 CANDLES. CAPITAL EXPENDITURE, £50,000.

Annual Expenditure, lamps burning 2,000 *hours per annum.*

Depreciation and repairs	£1,500
Slack coal, at 11s.	1,230
Water, at 6d. per 1,000 gallons	1,230
Oil, &c.	150
Wages and superintendence (30 persons) ...	2,968
Rent, rates, and taxes	250
Office expenses	250
Directors' fees	350
Renewal of incandescent lamps	2,000
10 per cent. dividend on capital...	5,000
Total required revenue	£14,928

14,000 14-candle gas burners burn in 2,000 hours 140,000,000 cubic feet, which would produce £15,000 at 2s. 1¾d. per 1,000 cubic feet. Gas in London is 3s. 2d. per 1,000 feet.

N.B.—It is not expected that each lamp erected will average 2,000 hours per annum, but that 2,000 hours is the average consumption of the maximum number alight at one time. Thus, if a house has 30 lamps but not more than 18 alight at once, the average consumption of that house will be 18 × 2,000 = 36,000 lamp-hours per annum.

The light obtained from 10,000 20-candle lamps is the same as obtained from 14,000 14-candle lamps burning 5 ft. of gas an hour, and they, burning for 2,000 hours, burn 140 million cubic feet of gas, which produces £15,000, which is the required revenue if gas is charged at 2s. 1¾d., the price in London being 3s. 2d. On the larger scale the economy is great. The larger scale we work on the cheaper per lamp will the light be. I am not at liberty to say what arrangements are being made, but I hope I shall shortly be able to commence putting up in the West-end of London such a plant as we have already erected; and we made an offer to a vestry, in a district in which we propose to put up the lighting, that we will guarantee that the maximum charge for a quantity of electricity equal to 1,000 feet of gas, shall never exceed 3s., and shall be reduced if we can do it. I will not enlarge any more on this, as it would savour much of a very vague scheme, for you to listen to to-day to what we propose to do, and it would savour somewhat of boasting for me to say it; but if this Society would do me the honour, in about a year's time, to ask me to read a paper before them again, then, if our work turns out as I hope and expect, I may be able to tell them not what we hope to do, but what we have actually accomplished.

DISCUSSION.

MR. **GEORGE OFFOR**, Manager of the South-Eastern Brush Electric Light and Power Company, while thanking Mr. Gordon for the valuable information he had given, said he should like to make a few observations on this interesting subject, being practically engaged as manager of electric lighting companies, and, therefore, somewhat familiar with it. The real difficulty they had to contend with was not any indisposition on the part of the public to adopt the new mode of illumination, because they were now to a large extent familiar with it, and as to the question of price, they were already aware of the fact that it could, with a fair amount of lighting, be supplied at about the cost of gas. The difficulty experienced had been this, that they had not possessed the power to supply. They were now obtaining provisional orders under the Electric Lighting Act, but they had not got them yet; they had no power to take up the streets, and put down mains, to supply the public in the same easy way that they were supplied with gas. Twelve months ago there was a great champion of one particular system, and no doubt he had a great deal to do with the development of the industry within the last year or two, but he changed his views, and took up with a machine of the same character as had been described that night; and the public began to think if this champion has changed his views we had better pause before we put down plant which would require thousands of pounds. With regard to the system described to-night, it seemed in many respects defective. What was required in electric lighting, for domestic purposes, was a steady light which could be regulated without the aid of two men, however intelligent they may be, to watch whether the lights were being turned on, or turned off, and then to turn a wheel to regulate the speeds, to prevent too much or too little current going into the lamps. They wanted an automatic arrangement for keeping the lamp steady, and a constant supply, whether an engine broke down or not. Now, in the development of electric lighting, both these objects had been obtained. He had been running regulators at Colchester for some months, where he had turned off the lamps put on to a frame one by one, until he had only a single lamp burning, and that had been regulated entirely automatically, so that whether there were only one lamp or 100 it would make no difference. This might be seen at Colchester at any time, where they were lighting a number of hotels and shops in the High Street, and the business was increasing, because there they had the power of putting down mains, and supplying the public in the same way as they were supplied with gas. Then, were they sure, under the system of Mr. Gordon, to get a constant supply without any check by the breaking down of machines. It was true that, by the expenditure of a certain amount of capital, you might have a reserve machine, but a reserve machine of such a gigantic size meant a large amount of capital, and even that reserve machine could not be put into action at once if one of the others broke down, and if the bearings of both machines in connection broke down, the reserve would only take the place of one, and in any case there would be a certain delay. That difficulty was got over by the only way, in his humble judgment, which was suitable for domestic lighting, namely, by means of a storage battery. In that way, if a machine broke down, you had a supply of electricity to draw upon, and, consequently, you might have the light day and night without keeping the station constantly going. Mr. Gordon had pointed out the advantage of the large machines, that you could dispense with the belt, but he was probably aware that there were steam-engines in connection with dynamos which ran direct without any belt. He might mention Hodgson's rotary engine, which was running a dynamo without any bands, and there were many important engines, with dynamos fixed to them, which ran in the same way. Again, something should be said in favour of small installations. When electric lighting involved such large figures, and such very large machines, he was not at all surprised to hear that local authorities suggested that a trial on so large a scale should be made at the risk, in the first instance, of those who believed in it. He believed the great bulk of the business they were likely to do for some time would consist of small installations, beginning with 100, 200, or 300 lamps, and increasing gradually. How did gas companies supply a town? By means of large gas holders from which they drew all that was required, and that was what his company promised to do; viz., by a storage system established in different parts of the town, and from that, drawing off, as from gasometers, the supply of current required by the public. Mr. Gordon had pointed out that, under his system, the lighting station should not be at any great distance from the supply, but that was not necessary under the system of the companies he managed. Their stations might be many miles away, the only inconvenience being the length of wire required to connect the stations with the storage batteries; but, by the use of a high tension machine, the current could be conveyed a long distance at a very moderate expense, so that they did not need to bring the lighting stations into the more expensive parts of the town, or to create a nuisance there, however unimportant. He had had the dynamo running for many months, and had received no complaints, even from the neighbours. He had also had offices lit for the last eight months by means of the storage system. He believed there was a great future for electric lighting, because they were now obtaining powers under the Act. The companies he represented had already agreed with local authorities and the Board of Trade for provisional orders for fourteen towns, and as soon as the necessary Act of Parliament was passed, the arrangements would be carried out. He knew from observations and inquiry that the public were quite ready to take the new illuminant as soon as they were able to supply it in the same simple effective way that gas was supplied.

MR. **C. G. GÜMPEL**, said he must agree with Mr. Gordon that the greatest difficulty electric lighting had had to contend with was stock-jobbery. What had caused the indifference shown to electric lighting was not the want of powers which Parliament had withheld, but chiefly the absolute loss which had been brought about by speculators. When they heard of the large sums which had been given to electric companies by the public, he would remind them that those sums were not paid to inventors, but were paid to promoters—to men who were the intermediaries between the practical men and the investor. He thought the history of this speculation ought to be written as a warning to future undertakings. We lived in a very different age to that of eighty years ago, when gas first made its appearance, and did now in five years what was then done in thirty. The first speaker had referred to an automatic regulator, and there was no question that they required it. At the present time there was no practical regulator in the market. Professors still spoke about dynamos which kept a constant potential at their terminals, and one suggested one plan and one another, but those acquainted with electrical literature would know how many different plans had been adapted. When the doctors themselves did not agree, what could be done? Mr. Gordon never said a truer word than when he referred to the necessity of making the plant of such a size that lighting could practically be introduced. It must be remembered that in introducing electricity they had to compete with gas, where one large gas-works supplied a whole town, and the question was to give the plant such a form as to take from a single engine enough power to supply the light required. They did not want small installations, for which it would be easy to devise small machines, and when they were recommended he imagined the wish was father to the thought. They wanted larger installations, because you could get them cheaper, as had been shown in the figures. Every electrician knew that. It was the same with gas. Mr. Gordon had solved the one great question of making a machine large enough to supply a town of medium size, and whenever the history of electric lighting was written, his name would stand forward as one who had shown the way. With regard to the storage battery, Mr. Offor was connected with the company which supported cumulative batteries, and hence it was necessary that he should advocate them; but Prof. Lodge, in that room a few days ago, speaking of the nature of storage batteries, said they were all very nice as long as you used them. You might charge them and discharge them, and they would act as long as you did so, but you must not let them stand. If you let them stand for any length of time, you required a very strong current to break through that thick coating of sulphate of lead which was formed on them, making an insulator which you could not penetrate. Suppose you had a battery in a house, and went out of town for a few weeks, and let it stand; when you came back and turned on the lights the battery would not charge, and you might wait until doomsday, but you would not get a current into it or out of it. He believed there were points connected with batteries which would make it a long time before their manufacture took a practical form. He had worked at the subject for five months, and had met with many drawbacks in their working.

Mr. **Rawson** said the figures which had been given were most valuable, and when they appeared in print must strike the public, especially in many places, particularly abroad, where gas cost 20s. a thousand cubic feet; it would lead people to inquire and see if there was not something in electric lighting. He would remark that it was not the price of the current, but the price of the light which was important, and the question was what you could get out of the lamps. If with a certain current you could double the illuminating power, you at once reduced the cost 50 per cent. Up to the present time incandescent lamps had not been worked at so much as the other parts of the plant, and there was no doubt they would be greatly improved, so that with a certain current a lamp of a greater power would be obtained and the price of the lamp reduced. They would then be able to run lamps with much higher candle-power. An ordinary lamp would now give twenty candle-power, with seventy volt-ampères, and last 2,000 hours; but if the price of the lamp could be reduced you could afford to work it for only 1,000 hours, and could get so much more light. The price of gas would, no doubt, come down; and the products which now fetched a good deal of money, if gas were less used, would become higher, and, therefore, electric lighting would have still further competition to meet.

Mr. **Gordon**, in reply, said he had listened with a great deal of interest to the remarks which had been made, and it was very useful to hear the views of other persons acquainted with the subject. With regard to the question of Stock Exchange operations, he did not think that was the place to discuss it. All he could say was, he did not agree with Mr. Offor, and nothing he had said had caused him to alter his opinion. He must leave it to the audience to say whether wild and reckless speculation, not in electric lighting, but in paper shares representing electric lighting, was likely to cause the public to adopt it as a safe and steady investment. With regard to the controversy between high and low speed dynamos, it had been going on for a long time, and was not finished yet, and it would probably take some years of work before the question was thoroughly decided. He was speaking chiefly not of what was used in small installations, but what was wanted on a large scale to compete with gas. With regard to driving direct from high-speed engines, he had seen nearly all such engines which were made, and there were plenty which would work very nicely, but he never saw a high-speed steam-engine which worked 500 revolutions—and the "Hodson" worked 1,500—that would be guaranteed for a year. He stood near one the other day for a few minutes, working at about 1,200 or 1,500 revolutions, and the noise was extraordinary; the whole place shook and rattled, and you felt, although it might last six months, or perhaps one year or two, the item on depreciation of plant of that kind would be something like ten times what he had put down. He believed he had been the only electrical engineer in England who had persistently said that storage batteries were worthless on a large scale. Storage was not analogous to pumping gas into gas reservoirs. You could not store electricity; you stored energy, and the analogy to storing energy was winding up a spring or pumping up water to a high cistern. Suppose you had a steam-engine which worked a quantity of machinery in a large factory, what would be thought if some one came to you and said if your engine broke down the shop must stop, so you must have storage; and told you to take off the belt, use the engine to pump water into a high reservoir, and let the water run down again, and turn a turbine and drive a shaft, and then you would be sure not to break down; they would not think much of the practical nature of such advice; and if he added you must pump it into a cistern which leaks very badly, they would think still worse of him. Storage certainly had its uses, particularly in small plant. If you had a little plant in a country house, where the steam-engine which did the pumping did a little electric lighting, and the wages of the engine driver would double or treble the expense, and you wanted the gardener to attend to it, who went home at 6 o'clock, then have storage; because if you lost half or two-thirds it did not matter, it would be cheaper than paying an engine-driver. But when you had plant of the size to compete with gas, you could afford to have men up all night. A question had been asked what would be the state of a storage battery after 2,000 hours. He had never heard of one which had worked 2,000 hours. With regard to capital expenditure, a point was made that a spare machine meant expenditure, and, therefore, storage batteries ought to be used instead, but the best storage batteries now in the market, capable of storing up current for 5,000 lamps, would cost more than a spare machine, he should think probably two or three times as much. As to regulation, he might say that all through the paper he had spoken, not of what they hoped would succeed, but what was actually practical. He had every hope that they would yet have automatic regulators and he had experiments now going on, but he did not feel justified in speaking of this as an accomplished fact until they had succeeded. If anybody would bring them a first-rate automatic regulator, they would be glad, if they found it useful, to adopt it, and pay royalty on it; the market was open to anybody at present. He was not aware of any regulator which worked perfectly with a large machine, so he had thought it better to discuss the matter, assuming the more expensive method, if hand regulation was to be adopted. With a small machine, automatic regulation was very useful and important, but with big machinery it was not always the wisest thing. In their experience at Greenwich, of coiling submarine cables into tanks, it was found better that it should be done by hand. They had tried a number of different patents for automatic coiling machines, but had not adopted any of them. If you wanted to reel cotton, you must regulate the flow by machinery, because you could not afford a man to each reel; but with a cable of the value of £50,000, a man more or less did not matter very much, and very often the expediency came in which made them decide to use hand regulation in preference. Still they had no prejudice, and were perfectly ready to employ automatic regulation if it were perfectly certain, and did not require a man to watch it. The question of incandescent lamps was very important and interesting, and he had all manner of hopes about the future, but he did not want the public to think that electric lighting people were mad, and if he told them what he believed would be done in the future they would not believe him; therefore he preferred to speak of what was actually accomplished, so in the capital expenditure he spoke not of estimates but of actual tenders. It was perfectly certain that every improvement in the lamps was a direct gain to electric lighting companies and the public. Engines, dynamos, mains, transferred the energy of coal or water into electricity, and the more perfect the dynamo, the more electricity you obtained for so much fuel. But then before the electricity came to be of any use to the public it had to be changed again into light, and the quantity of that light produced depended on the lamp. The cost of the light depended on the amount of energy consumed, and that depended on the temperature which the filament would stand; the higher you could raise the temperature the higher would be the candle-power per horse-power. To give a simple illustration, if you took a red-hot poker into a room, there was a great deal of energy but very little light; but if you had a little platinum spiral made white-hot, there would not be one-tenth the energy, but much more light. Step by step, as the manufacture of lamps advanced, they would be able to work them at a higher temperature and still be able to guarantee them for 2,000 hours, and with every step of that kind there would be a great gain. Therefore, they were looking forward to the perfecting of the lamp as a means of perfecting electric lighting, and meeting every reduction in price which the gas companies would make. He had endeavoured to speak not of these fascinating expectations they all indulged in, but what was required for a plant which a responsible company was now prepared not only to erect, but to guarantee the successful working of.

The vote of thanks was carried unanimously.

THE CARRYING POWER OF MAGNETS.

THE carrying power of magnets varies considerably with their form, their disposition, the number of plates which compose them, the nature of the steel, its temper, &c. We may, however, form some idea of the average power of magnets of the same quality, temper, and disposition (horseshoe) by applying the empirical formula of Bernouilli—

$$p = a \sqrt[\frac{3}{2}]{w}$$

p, weight which the magnets will carry in kilogrammes; w, weight of the magnet in kilogrammes; a, a co-efficient, which for steels of good quality varies between 18 and 23.

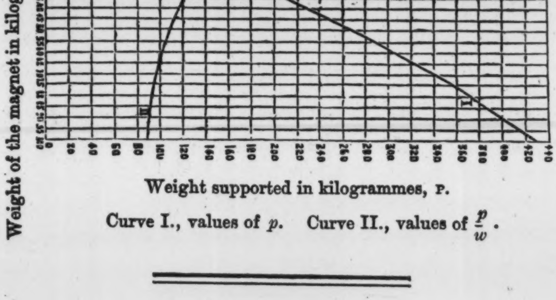
The curve obtained by M. Séquard, a student of the Ecole de Physique et de Chimie Industrielles de la Ville de Paris, represents the results furnished by this formula for $a = 20$.

We see, says *La Nature*, that this weight increases more slowly than the weight of the magnet itself, that is to say, small magnets are much more powerful than large ones. This fact is shown by the second curve, which represents for each weight of magnet, w, the number of times its weight $\left(\frac{p}{w}\right)$ that the magnet can carry. We see, for instance, that a magnet of five kilogrammes can carry more than eleven times its own weight, whilst a magnet of 50 kilogrammes only carries five times its weight. It is in order to utilise the relatively very great power of very small magnets that the needles of the Thomson galvanometer are composed of three or six small watch springs only three to four millimètres long, fixed upon the small mirror, instead of one small magnet of the same weight as the whole of them.

It is in consequence of the decrease of power of magnets with their weight that small bobbins are exclusively employed in magneto-machines, and that it is necessary to have recourse to the dynamo when the bobbin destined to move in the magnetic field attains large proportions.

Relation of the weight carried, P, to the weight of the magnet, W.

$\left(\frac{P}{W}\right)$.



Curve I., values of p. Curve II., values of $\frac{p}{w}$.

Society of Arts Awards.—Among those to whom the Council of the Society of Arts have awarded their silver medals are Mr. Alex. Siemens and Dr. Hopkinson, for their papers on "The Transmission of Power by Electricity," and "The Portrush Railway."

NOTES.

Electric Lighting.—On Friday evening, May 25th, some highly interesting experiments with the electric light were made in the yard adjoining the ancient guild house in Earl Street, Maidstone, which is now used as a cooperage, by Messrs. Fremlin Bros., brewers. The principal object of the display was to show the inventions of Mr. A. J. Jarman, of London. The motive-power was supplied by one of Crossley Brothers' gas-engines, which is ordinarily used for driving the sawing machines of the cooperage. The lamps employed were thirty incandescent lamps in the engine-room, an arc lamp of 2,000 candles in the saw mill, and another of 6,000 in the open yard. The lamp in the saw mill was intended to demonstrate that it was unaffected by the dust in the atmosphere of mills and factories. The lamp referred to had been in the saw-mill for a fortnight, and now burned with brilliancy and regularity. Mr. Jarman's dynamo-machine possesses the advantage of being suitable for either arc or incandescent lamps. It is also peculiarly adapted for charging accumulators, and it is claimed to be most economical. The machines used were principally constructed in Maidstone, where the inventor intends to turn them out in large numbers. The *Maidstone and Kent County Standard*, from which we take the above particulars, concludes in the manner peculiar to newspaper reports: "Another most interesting feature in the display was the working of a small electric locomotive on a circular tramway, 62 feet in diameter. The machine, which weighed 5 cwt., was illuminated by two incandescent lamps, and aroused great interest among those who watched it rattling along at the rate of fifteen miles an hour, propelled by a current equal to 4,000 candles. A practical engineer who was present gave it as his opinion that, taking into consideration the additional friction caused by the circular route, and the perpendicular position of the machine while going round an endless curve, the speed attained was equal to 60 miles an hour on a straight road." Mr. Jarman gives us these additional items of information: The quantity of gas consumed in one hour and a quarter was just 500 cubic feet, which if burnt through one of the best forms of burners would give but 4,000 candle-power, while Mr. Jarman was enabled to get an actual 12,000 candle-power in light from his arc lamps. 500 feet of gas cost, in Maidstone, 1s. 11d., the carbon consumed cost 9d., and of course a small amount for wear and tear of engine, interest on outlay, oil and engine man's wages must be added, but even then, says Mr. Jarman, it leaves gas far behind both in cost and illuminating power.

From recent tests (May 26th) made on the "Cruto" incandescence electric lamp, at the laboratory of the "Association for the Study of Electricity," Paris, we note the following results:—

Type of lamp.	Electromotive force. Volts.	Current. Ampères.	Luminosity in stan. candles.	Remarks.
32-candle	57·6	1·76	36·25	1st experiment
,,	63·60	1·94	59·0	2nd ,,

How do these results compare with some of the better known lamps now in use? We are informed that sixteen 20-candle-power "Cruto" lamps can be obtained per horse-power expended in the lamps; but the above tests do not point to such a high degree of efficiency.

A use has been found for the electric light in California. A grand electric fishing establishment is established at the island of St. Catalina, opposite the port of San Pedro. The light will be submerged in a thick globe of glass, and will act as a lure, nets being spread around which will be drawn from time to time with the catch of fish.

The Royal Cornwall Polytechnic Society will open its fifty-first annual exhibition at Falmouth on the 11th September next, and offers a premium for any new and successful experiment in the application of the electric light for use in mines or otherwise.

The s.s. *Burwah*, 2,000 tons, built by J. Key & Sons, Kirkcaldy, has just been completed and is fitted up with the electric light, Higgs' self-regulating dynamo being employed.

Seventy incandescent lamps of 20 candle-power and two arc lamps of 2,000 candle-power are used. Satisfaction has been expressed on all sides, the extreme softness and steadiness of the light being commented upon. The work has been executed by the Electric Carbon, Storage, and Apparatus Manufacturing Company of Scotland (Limited), Leith.

The Croydon Town Council met on Monday of last week when the Mayor intimated that the gas contract expired on the 21st inst., but that Mr. Foss had arranged for its continuation for a fortnight. They had better refer the matter to the General Purposes Committee with full power to act. Councillor Oelrichs thought the arrangement had better be a temporary one, and that the committee should report to the council, because there was the electric light to be considered. The Mayor replied that they could not get the electric light in six months. They did not want the borough to be in darkness in the meantime. The suggestion of the Mayor was then agreed to.

A correspondent writing to the *Globe* says :—"It does not appear to have struck any one that the Fisheries Exhibition may not be the safest place in the world for numbers of the public when opened at night and lit by the electric light. So far there has not been any preparation for a duplicate system of lighting the buildings. In case a driving band of an engine breaks, or other accident happens, large sections of the parts visited by the public will be instantly plunged into total darkness. It would not be a very enviable position for one to find oneself in a struggling, panic-stricken crowd of some 2,000 or more visitors under such circumstances."

The Guion Liner *Oregon*, launched from the shipbuilding yards of Messrs. John Elder & Company, Govan, on Saturday last, is to be lighted throughout by incandescent lamps.

The electric light has been applied with so much success to the s.s. *Cavalier*, one of the Caledonian Canal line of steamers, that the Messrs. McBrayne have decided to extend the light to their other vessels. The work, we believe, has been intrusted to Messrs. Anderson & Munro, of Glasgow.

The experimental electric lighting of the Holborn Viaduct with Edison's incandescent lamps having been in operation for a period of twelve months, on the 24th April last, Colonel Haywood has made a report on the subject up to that date to the Streets Committee of the Commissioners of Sewers.

An agreement was entered into on the 2nd January, 1882, Mr. Johnson, the manager, undertaking on the part of the Edison Company to light the Viaduct for three months, between the 1st of February and the 30th April, 1882, free of cost to the Commission. Owing to various circumstances the lighting of the Viaduct was not commenced until the 24th April, 1882; it was then in thorough working order and the ordinary gas lighting was dispensed with. The lighting having been in operation for a period of three months on the 24th July, 1882, the Edison Company applied to the Commission to have the experiment extended for a further period of six months from the date named, upon the Commission paying the same amount for electric lighting they would have had to pay for the ordinary gas lighting during that period. This was agreed to, and the lighting was continued until the 24th January of the present year. Subsequently it was agreed that the contract should be extended for a further term of twelve months from the 24th January of the present year, upon similar conditions, the Commission reserving to itself the right of determining the contract upon its giving ninety days' notice of its intention to do so.

The number of incandescent lamps in use for lighting the public-way when the experiment first commenced was 176—of which 156 were each of 16 candle-power, and 20 each of 8 candle-power—two 16 candle-power lamps were placed in the majority of the ordinary gas lanterns, and several groups of eight candle lamps were placed in the lanterns at other places. This arrangement was modified towards the end of August last, the two incandescent lamps in each gas lantern were removed, and one lamp (said to be equal to about 16 candles) was placed in each of the ordinary gas lanterns. The lamps on the five-light column at the eastern end of the Viaduct, and on that at the junction of the Viaduct and Snow Hill, were also removed, and large lanterns, octagonal in plan, each enclosing eight incandescent lamps, were placed in them. Each incandescent lamp is said to have been equal to 16 candle-power. The incandescent lamps were arranged so as to be removed, and the gas to be immediately lighted in the event of a failure in the electric light. The total number of incandescent lamps in use during the latter part of the experiment, or, as it may be said, when the experiment was in complete operation, and as at the present time, is 92. The total number of incandescent lamps, however, on the line of the Viaduct, in use in private premises, and maintained from their works, is about 745. The total length of thoroughfare lighted is about 466 yards, and the superficial area about 12,400 yards; each incandescent lamp upon the Viaduct illuminates an area of about 155 yards superficial.

The illuminating power of each of the incandescent lamps in use since August is stated by the company to be about 16 candles. The number of gas lamps disused while this experiment has been in operation is 86, each consuming five cubic feet of gas per hour, the illuminating power of which is estimated at about 14 candles each.

The illuminating power of the incandescent lamps is assumed to be about 1·22, or say, 1¼ times as much as that of the ordinary gas lamps. The cost of the gas lighting on the Viaduct at the present contract price to the Commission would be £388 8s. 8d. per annum, and the Edison Company light the Viaduct for that price. This is at the rate of £4 10s. 4d. per lamp per annum.

The extent and nature of the failures in the Edison system during the year is briefly stated as follows :—There were for the first portion of the experiment, until the end of August last, 176 incandescent lamps in operation, that is two lamps in the majority of the 86 gas lanterns, and several groups of eight lamps, each assumed to be alight 1,052 hours from the 24th April to that date, which is equivalent to 185,152 hours lighting of a single lamp. There were 92 incandescent lamps in operation for the remainder of the twelve months, each assumed to be alight 3,228 hours, which is equivalent to 296,976 hours lighting of a single lamp.

These together are equal to a total of 482,128 hours lighting of a single lamp. The total number of failures in the lighting from all causes was 815, counting every failure each night separately; their aggregate duration was equal to 1,515 hours of a single lamp, or about ·03 per cent. of the entire lighting for the twelve months. It may be said broadly that a defect of longer or shorter duration occurred in something like 1·17 lamps nightly out of the 176 lamps lighted in the first portion of the year, and 2·80 lamps nightly out of the 92 lamps lighted during the remainder of the year. The principal failures appear to have arisen from defects in the machinery, and many from defective carbons in the incandescent lamps.

A list of the defects and failures is given in an appendix to the report, from which it appears that in five cases a complete breakdown occurred, and in other cases 18, 16, 12, 12, 8, and five lamps respectively were extinct, besides many instances of one and two. The majority of these latter failures are said to be due to broken filaments.

The Railway Electric Appliances Company.—Before Vice-Chancellor Bacon, in the Chancery Division of the High Court of Justice, Mr. Millar, Q.C., appeared in support of a petition for the winding-up of this company, presented by the Duke of Manchester and the majority of the directors of the board. Only two directors, Mr. Millar explained, did not support the petition. The company was formed in March, 1882, to take over three contracts in regard to patent rights—one from the Williams Company, another, which included what was called the Kennedy lamp, from the National Electric Company, and the third from the Electric Light Company. Mr. W. Alexander Smith, who was upon the direction of the Railway Electric Appliances Company, and who did not support the petition, was the chairman of the Williams Company, and he and two other gentlemen who were connected with the Williams Company, or the National Electric Company, were the promoters of the company now desired to be wound up. A large number of shares in the company were allotted fully paid up to the selling companies and their nominees. The company had paid no dividend, and the representations on which its promoters were induced to take over the patents from the Williams Company and the National Company proved to be unfounded. At the date of the petition the actions brought by the shareholders to be relieved of their shares, on the ground of these misrepresentations, numbered 67, and they had since increased to 75, representing 33,601 shares, and in addition to these, on the 16th of May last, an action was brought by the counsel against the Williams Company and the National Company to be relieved of these worthless patents, including the lamp, or in other words to set aside the two contracts which really formed the operations of the present company. The petitioners were advised by a person of eminence that the best course to adopt was to put the Railway Electric Appliances Company under the protection of the court. It was not right to allow certain shareholders to get off in consequence of misrepresentations which probably affected the whole body of shareholders. On the 22nd of May last, Mr. Young, of the firm of Turquand & Young, was appointed liquidator, and had been in that position since. At that time a circular was sent out by the Duke of Manchester and the other petitioners, stating that a committee which had been appointed to investigate reports which had reached the board of the circumstances under which the company was formed, reported that the anticipations of profit to be derived from the patent rights had not been realised. Mr. Hope, representing the company, supported the petition. Mr. Martin, Q.C., who appeared for Mr. W. Alexander Smith, urged that the proper course would be to allow the petition to stand over, so that a meeting of the shareholders might be called to decide on the course to be adopted. The further hearing of the petition was adjourned till to-day.

Faure-Sellon-Volckmar Accumulators.—M. Emile Bürgin, of Basle, has by an arrangement with the Electrical Power Storage Company, Limited, secured the sole agency for the supply of the Faure-Sellon-Volckmar accumulators in Switzerland.

The late Illuminations at Moscow.—The following are the details which we observe of the method by which the illuminations at Moscow at the coronation were produced:—The Tower of Ivan the Great and its side galleries were lit up by 3,500 small Edison lamps, worked by 18 portable engines, which moved a number of dynamo-electric machines of every existing system. The portable engines and machines were kept at the other bank of the Moskwa. The sheds communicated with the tower by 70 overhead wires. On the ramparts of the Kremlin towards the river eight large and ten smaller electric suns threw their light over the river. The rest of the illuminations consisted in 200,000 lamps and 30,000 coloured glass globes, 50,000 lanterns of Venetian glass, 600,000 tapers, and 10,800 lbs. of fireworks.

Sir Charles Dilke and Overhead Wires.—On Monday, Sir Charles Dilke, the President of the Local Government Board, received a deputation, consisting of representatives of nearly forty of the Metropolitan Vestries, the City Commissioners of Sewers, &c., on the subject of overhead telegraph wires. The deputation, after enlarging on the danger of overhead telegraphic and telephonic wires, insisted that the vestries had no power to prevent their erection. Sir C. Dilke, in reply, said that the owners of the wires had no greater rights to interfere with the streets, or with placing wires across the streets, than any other member of the public—that they were, in fact, in the position of ordinary individuals. The Government did not think that they could, either with or without the control of the local authorities, interfere with the public highways in such a way as to cause obstruction to the public, even though such an obstruction were limited to the time they were executing their works. Then, again, while the Government were not prepared to say that it would be unlawful to carry wires over buildings across the streets, where the consent of the owners had been obtained, it was a question of fact in each case, whether the wires were suspended in such a manner as to be a probable cause of danger and probable damage as to constitute a nuisance. That would depend upon a number of considerations. Up to the present time there appeared to have been no great danger or destruction caused by these wires; but he was prepared to admit that he agreed with the deputation in thinking that there was great risk of such danger in the future. Telephonic wires in many places were extremely close together, and in the event of a partial frost or a partial thaw might cause serious destruction. With regard to the point urged as to whether they had any powers of interference, he agreed with the deputation that if they did not possess those powers they ought to be obtained, and he agreed that it ought to be made clear whether those powers existed or not. Their view was, in fact, that the vestries had the power already. If there was a distinct probable nuisance, or if any one were killed or hurt, the persons who had put up the wires would be responsible. He was of opinion that if a few cases were tried, it would be found that the vestries had at the present time sufficient powers to prevent the erection of wires in the way described, and he could not but think it would be desirable to make that point clear before legislation was attempted. There was sure to be opposition to such legislation from certain quarters, and he thought it would be wise to have the question cleared up. He would go so far as to say that if it should be found the local authorities had no power to prevent the uncontrolled erection of those wires, legislation on the subject ought to take place.

In the House of Commons on Monday, Mr. Stuart-Wortley asked the President of the Local Government Board whether it was the fact that overhead telegraph and telephone wires were in some cases stretched across streets, not only by Her Majesty's Post-office, but also by persons not empowered to do so, either by Act of Parliament or by any licence from the public bodies in whom was vested the soil of the street across which such wires were stretched; whether there existed any means of ascertaining the number of overhead wires in the metropolis which belong to private owners or companies which have ceased to use them, or for other reasons have ceased to keep them in repair. Sir C. Dilke said his answer to the first part of the question would be in the affirmative, but some of the vestries were inclined to dispute the extent of their interest in the soil of the streets in reference to this question. As to the second part of the question, many of the vestries stated that there were many miles of such lines in their districts, many that there were none, but the greater portion said they were without information on the subject. There could be no doubt that in the City and Westminster there were a certain number of abandoned lines. The Vestry of St. Mary, Newington, stated that if any such existed in their district they would immediately take steps for their removal. The reply of the Vestry of St. Giles showed that in the opinion of some vestries ample power existed in the present state of the law. They said, overhead telegraph and telephone wires had been stretched across the streets, but in all cases where the owners of abandoned wires had been ascertained the Board had taken steps to order their removal, or where they had permitted them to remain, to be subjected to proper supervision. The increase of overhead wires in the district was constantly watched and dealt with by the Board's inspectors, but it was believed that in many districts it was disregarded. The whole of the legal points at issue were raised in a series of actions brought by the Local Board of Wandsworth, and until these actions were decided it would be premature to express any opinion as to the necessity for further legislation on the subject. Mr. Stuart-Wortley asked if those vestries which disputed their interests in the soil also disputed their liability for injury, and Sir C. Dilke replied that the liability was in the person who erected the wires. The question of liability where no owner could be found had not yet arisen.

The Fisheries Exhibition.—The galleries and courts of this exhibition were lighted up for the public on Wednesday night. We learn that fifteen firms have sent their lamps and machinery; and on how large a scale the lighting experiment has been carried out may be gathered from the facts that the covered portion of the exhibition illuminated is seven acres in extent; that the installation covers 23 acres; that over 25 miles of conducting wires are used; that 56 dynamo-machines are employed in the generation of electricity; that a capital of £45,000 is represented in the carrying out of the work; and that to drive these machines and supply the light of nearly 4,000 incandescent and 280 arc lamps, equivalent to nearly half a million candles, steam engines of 1,100 indicated horse-power are running. The vestibule is lighted with 350 Woodhouse and Rawson lamps and Elphinstone-Vincent machines, and the British Sea Fisheries Gallery, with 1,040 Swan lights, of 20 candle-power each, arranged by Messrs. Siemens Brothers and Co., to which the current is supplied by two Siemens alternating current machines. Messrs. Siemens have also illuminated the great conservatory very successfully with four arc lamps, in parallel, of 5,000 candle-power each. The lamps are of the ordinary Siemens pattern, such as are used with single-light machines, and they are worked without the shunt regulating coil required when lamps are worked in series.

The Newfoundland, Netherlands, and Belgian courts are lighted by the Jablochkoff system. In the Swedish and Norwegian courts the lighting is effected with 15 Brockie arc lamps, supplied by a Gramme machine. A remarkably brilliant and steady illumination of the Canadian and United States courts is obtained with 15 Lea arc lamps, driven from three Gramme machines. The Spanish and Russian annexes are to be supplied with 10 Gérard arc lights each, those in the first-named court run by a Siemens direct current machine and the Russian by a Gérard compound Gramme. The long central promenade allotted to the British freshwater fisheries was lighted by Mr. Henry Edmunds with 25 arc lamps of the Hochhausen pattern, worked in series by a continuous current Hochhausen machine, absorbing 20 horse-power and delivering a current of 10 ampères. From the arches of the roof of the eastern gallery in which are the collections of China, New South Wales, India, the Straits Settlements, Japan, Chili, and France, &c., some 600 Crookes incandescent lamps are suspended, each lamp being covered with a coloured semi-transparent reflector. The current is supplied by two large and one small Gülcher low tension dynamos, the circuits being so arranged that all the lights hung on the odd-number arches are served by one machine, the even-number arches from the other, and a line of lights in the spaces between the arches by the small machine. The lighting of this court has been carried out by the Gülcher Electric Light and Power Company. The dining gallery is illuminated by 28 arc lights on the system of Mr. Charles Lever. The pavilion of the Prince of Wales is lighted by 184 Swan lamps, tastefully arranged so as to show the interior to advantage. The steam machinery for driving all the dynamos is supplied by Messrs. Davey, Paxman & Co., of Colchester.

Bennett's Patent Iron Battery.—The Electromotive Force Company (Limited) of Glasgow is prepared to supply Bennett's battery in any numbers. This battery was fully described in the ELECTRICAL REVIEW for February 18th, 1882, and it is now to be obtained in three sizes called respectively X, Y, and Z. Type X, the largest, is said to be adapted for any purpose to which the corresponding size of Leclanché can be put, and has the further advantage of possessing sufficient constancy for use on the busiest telegraph lines and on local or relay circuits, and for working telephonic transmitters, medical and other coils, and electric bells and indicators in busy hotels or warehouses. Type Y, the middle size, is also applicable to all the above-named purposes in a modified degree, but is more specially adapted for telephonic transmitters, in working which we understand it gives most satisfactory results. Type Z, the smallest, is extremely useful for actuating domestic bells and indicators, fire and burglar-alarms, working telephonic transmitters on not very busy circuits, and many other purposes which require an energetic but not constant current. We cannot say from experience anything regarding the constancy of these cells, but we have on various occasions seen reports in their favour. They are, moreover, sufficiently inexpensive to deserve a trial.

Obituary.—Mr. W. Spottiswoode, F.R.S., who has been ill for some weeks, died on Wednesday morning. He was born in London in 1825, and educated at Eton and Harrow. He graduated at Balliol College, Oxford, as first-class in mathematics in 1845, and gained other university distinctions. On leaving Oxford circumstances rendered it necessary that he should take the management of the business of the Queen's printer. He has, however, always found ample time to devote himself to his favourite studies of mathematics, philosophy, and languages, and to take an active part in the proceedings of the various learned and scientific societies to which he belonged, including the Astronomical, Royal, Geographical, Asiatic, and Ethnological, as well as the Society of Arts. He was elected President of the British Association at the Dublin meeting in 1878, when the honorary degree of LL.D. was conferred upon him by the University of Dublin, and since that date he had been President of the Royal Society.

General Sir Edward Sabine, R.A., K.C.B., died at Richmond on Tuesday, at the advanced age of 94 years. He was born in Dublin October 14th, 1788, and was the youngest of a large family, whom he has long survived. He served in the American war, 1813-1816, was present in the campaign of 1814 on the Niagara frontier, and was favourably mentioned in dispatches. On the conclusion of the war he was appointed, on the recommendation of the President and Council of the Royal Society, astronomer of the first expedition in search of the North-West passage—viz., the expedition commanded by Sir John Ross in 1818—and on the return of that expedition accompanied the second expedition of 1819-1820, commanded by Sir Edward Parry, in the same capacity. In 1821-1822 he was employed by the Government in conducting a series of pendulum experiments for determining the figure of the earth at several stations at or near the equator on the coasts of Africa and America, in H.M.S. *Pheasant;* and in the following year (1823) he proceeded in H.M.S. *Griper* to extend the series to Greenland, Spitzbergen, and Norway. In 1825 he was appointed with Sir John Herschel the British members of a Joint Commission between the French and English Governments to determine the precise difference of longitude between the observatories of Paris and Greenwich by means of rocket signals. In 1827 he was employed in determining by direct observation the difference in the length of the seconds pendulum at Paris and Greenwich, and of the magnetic force of the earth at the same stations, and in the same year he accepted the office of Secretary of the Royal Society. In 1828 and 1829 he was engaged in various scientific investigations, of which the accounts are published in the "Philosophical Transactions." In 1836 and 1837 he presented to the British Association an account of a magnetic survey of the British Islands, and a report on the variations of the magnetic force in different parts of the globe. In 1839 he was appointed to superintend the proceedings at the magnetic observatories established in the colonies, and to reduce and publish the results obtained at them, as well as those of a general magnetic survey of the globe, commenced at that period, under the direction of the Admiralty. In the same year he was elected General Secretary of the British Association, in 1846 Foreign Secretary of the Royal Society, and in 1850 Vice-president and Treasurer of that Society. In 1861 he became President of the Royal Society, which office he retained until 1871.

OFFICIAL RETURNS OF ELECTRIC COMPANIES.

Kelway's Electric Log Syndicate (Limited).—The return of this company, made up to the 19th inst., was filed on the same date. The nominal capital is £6,500, in £10 shares. Upon 400 shares the full amount has been called up, and half the amount upon 175. The calls paid amount to £4,679, leaving £196 unpaid. Registered office, 51, Lombard Street.

River Plate Telephone and Electric Light Company (Limited).—The annual return of this company, made up to the 13th inst., was filed on the 20th inst. The nominal capital is £100,000, in £5 shares. 8,616 shares have been allotted and £5 per share called up, the calls paid amounting to £43,080. Registered office, 34, Walbrook.

Electrical Trading Company (Limited). — The return of this company, made up to the 14th inst., was filed on the 17th inst. The nominal capital is £10,000, divided into 500 ordinary and 500 deferred shares of £10 each; 170 ordinary, and the whole of the deferred shares have been taken up; upon the former £5 per share has been called, and the full amount upon the latter. The calls paid upon the ordinary shares amount to £717 10s., and upon the deferred shares to £5,000, leaving £132 10s. unpaid upon the former. Registered office, 23, Farringdon Street, E.C.

NEW COMPANY REGISTERED.

American West Coast Telephone Company (Limited).—Capital £200,000, in £5 shares. Objects: To purchase the shares and property of Las Compania Chillua de Telephonos de Edison. Signatories (with one share each): J. Tillman, 16, Camden Street, Colebrooke Row, N.; G. G. L. Macpherson, 39, Lombard Street; D. A. Davis, 18, King Street, E.C.; J. Ware 15, Gayton Road, Hampstead; W. Barrett and B. Dale, 75, Cornhill; A. E. Kent, 78, Devonshire Street, E. An agreement of the 11th inst., between José Dollin Husbands and Robert Smith will be adopted. Registered 20th inst., without articles of association, by Newman & Co., 75, Cornhill.

CITY NOTES, REPORTS, MEETINGS, &c.

The Faure Electric Accumulator Company Limited:

THE second ordinary general meeting of the shareholders was held at the Cannon Street Hotel, on Tuesday, M. Philippart presiding.

The Secretary (Mr. H. Canning) read the notice convening the meeting, and the report and accounts were taken as read.

The Chairman, who spoke in French, and was interpreted by Mr. Campbell, solicitor to the company, said the shareholders had already received a translation of the letter which he wrote and published in France and Belgium, and therefore he would not now refer to the subject with which it dealt, unless in answer to questions. A person, not standing alone, but who came from the Belgian Government with whom he had an old question still pending with respect to Belgian railways, had a spite against him. Their enemies, by which he meant those engaged in matters of electricity different from theirs, would endeavour to profit by the proceedings now pending against him, but having taken great precautions, and used great efforts, he had been enabled to maintain the situation as before. The agreements which he was entering into, or about to enter into, with the government, and other persons in France, still remained to be carried out by him as soon as the Belgian question was finally settled. He thought that would take place within the next fifteen days, and he believed it would terminate in a way most favourable to himself. He would now give them some account of the traction used in the tramcars in Paris at the present time. Altogether there were 600 tramcars in Paris, or what might be considered equivalent to 600, and each carried 50 passengers. These cars were very much heavier than the English cars. The tramcar, with the accumulators, weighed about nine tons. The cost of the traction power of each car in Paris was about 60 francs a day. It was considered that the expense of the traction power of the London tramcar was about 40 francs. The London car accommodated 40 passengers as against the French car's 50. Each tramcar in Paris, it was considered, earned a profit of 12 francs a day; that calculation was taken from the accounts of the company, and each car in Paris required 14 horses during the day. He considered that the cost of horses, harness, and all other expenses, brought the cost of each car up to about £800.

Mr. H. Turner thought it would be far more favourable to the shareholders if they were to enter into the business of the meeting instead of listening to these details.

A director was of opinion that as they were so largely interested in the French company it was to their advantage to hear these particulars.

Mr. Turner replied that the shareholders were satisfied there was work to be done; what they were anxious to learn was as to whether or not they had funds to carry out the work.

The Chairman (Mr. Campbell interpreting) referred to the fact that this company had no longer anything to do in England. The shareholders approved of the sale of the residue of their English patents to the Sellon Company, and they took an interest in lieu thereof in that company. As the patents were worked in France, and as all the profits had to come from the working of the French patents, he thought it necessary to give them some details of what was being done with the patents in France.

In reply to shareholders,

The Chairman said the experiments which were now being conducted in Paris were for the purpose of proving to the French people the value of these accumulators. There would be no difficulty whatever in having sufficient capital to carry out the undertaking in Paris as soon as people were satisfied that the work could be done.

A Shareholder thought, considering the position in which the company was placed, that no directors were wanted at all, and that a secretary would suffice to do all the work that was required to be done in England.

Mr. Turner desired to know the meaning of the remark, "Signed with a reservation the nature of which I shall explain at the general meeting."

Mr. Campbell replied that on one side of the accounts were "Forfeited shares £50,854," and on the other side, "Amount paid on 25,427 shares forfeited, of which 18,000 had been re-issued, £50,854." Those two items balanced one another. The facts connected with those forfeited shares were these. Some time ago M. Philippart, seeing that the £25,000 that had been paid for the English Faure patents had disappeared, as they had given up their interest in the English Faure patents, and seeing that certain sums had been expended in preliminary expenses—the two amounting together to £43,000—considered that £43,000 of the capital had disappeared. There were standing in M. Philippart's name shares belonging to the company *La Force et la Lumière*, on which £50,000 had been paid. He was desirous of assisting the Faure Company, and he considered by allowing those shares on which £50,000 had been paid to be forfeited that that would be replacing the £43,000 which had been paid for the English patents and spent in different preliminary matters; and the proposal he made to the Faure Company was, "I will allow my shares to be forfeited, whereby you get rid of £50,000 capital, which you can put against the £43,000 that has been spent and expended." That was agreed to, and M. Philippart's shares were forfeited; but he made a condition that as he was giving up £50,000 he was not to be called on to pay the remaining £50,000 due on his shares. There would be no object in giving up £50,000 with one hand and having to pay it with the other. Therefore when these accounts were sent to him M. Philippart at once said, "When I gave up my shares to you in order that £50,000 of the capital might disappear, it was understood that I should not be called upon to pay any future calls on those shares; therefore, subject to that reservation I sign these accounts."

A Shareholder: Has he made the handsome present to the company of £50,000?

Mr. Campbell: He considers he has.

A Shareholder asked if M. Philippart was the largest shareholder in the company *La Force et la Lumière*. He was told he was. What M. Philippart gave to this company was not given to it but to himself.

The Chairman said it was very true that he was the largest shareholder in the Company *La Force et la Lumière*. That company held at least three-fourths of the shares of the Faure Company, so that when the Company *La Force et la Lumière* gave up that £50,000, three-fourths belonged to themselves and the other one-fourth they gave up which the Faure Company benefited by.

Mr. Campbell: The shares standing in his name were not his, but belonged to the Company *La Force et la Lumière*.

After some further remarks by shareholders,

Mr. Campbell said it appeared to him that they, as a body, decided that it was to their advantage to part with the remaining interest they had in the English patents, and to become interested in the French patents in lieu thereof. A special meeting was called for the purpose, and they came and unanimously ratified that they would part with the remainder of their interest in the English patents to the Sellon Company. Those French patents had to be worked in France. M. Philippart's object was to tell them what was being done with those patents in that country.

Mr. Thomas said both Mr. Campbell and the shareholders must remember under what influences the resolutions were carried at that special meeting. An immediate dividend was to be paid, and something like £4 per share was said to be in prospect by the month of February. Shareholders would do anything as long as they got large returns, but what had become of the returns promised them in order that the matter might be pressed on the shareholders?

Mr. Staple thought that a discussion at that moment was premature. Let them hear what M. Philippart had to say and then argue the matter.

The Chairman said the only way, he considered, to put them in possession of information was by his going on in the way he had been, but if he had lost the confidence of the shareholders he did not wish to remain there a minute longer. He had the whole of his fortune in the enterprise—if the accumulators did not succeed he was a ruined man. The result of his calculations and the experiments made was that the transaction which now cost 40 francs a day would, by means of electricity, be reduced to 20 francs a day.

Mr. Thomas considered that the work of the French company; they had nothing to do with it.

Mr. Campbell: This is how the French company are to make their profit, and the more profit the French company make the larger dividends will the shareholders have in England.

The Chairman went on to contend that a large profit could be made out of the patents in Paris. He proposed to go on with his experiments for the next fifteen days, and in his opinion the owners of the traction cars would become so satisfied with the patents that there ought to be no difficulty in making arrangements with them to get some of the large profits they would save. He was not talking of lighting, but simply of traction power. Without these accumulators lighting could not be carried on in a practical way. For the last three months he had made no progress, but that was not his fault. All he had got to do now was to work on quietly with all the perseverance he could.

A Shareholder asked what assurance had they that at the end of fifteen days M. Philippart would be quite safe.

The Chairman did not see how the affairs of the company could go on without him, but he himself had no fears of the result of the charges against him.

A desultory discussion followed in the course of which,

Mr. Solomon asked if it was not a fact that since the formation of the company accumulators had been invented of far greater value—that could be worked with much less cost—than the accumulators of which they held the patents. He had read something to that effect in the ELECTRICAL REVIEW, and he believed there were several such inventions, not infringements of their patents.

The Chairman replied that for a long time back, almost every day somebody had invented an accumulator, and almost every day somebody had come to him offering him an accumulator, but he considered the Faure accumulator the best; there was not one that beat it in value.

A Shareholder asked how the accumulator, in the chairman's opinion, was better than every other body's?

Professor Ayrton, having been appealed to to reply, said he was perfectly willing to state, and he had had the means of testing several, that up to the present day he had seen no accumulator whatever to compare, electrically or commercially, with the Faure-Sellon-Volckmar accumulator. (Hear, hear.)

On the motion of Mr. Staples, seconded by Mr. Thomas, the meeting was adjourned to the 15th October, by which date a decision would be given in regard to the proceedings now pending against M. Philippart.

The Western Union Telegraph Company.—The quarterly report of this company states, that for the quarter ending March 31st, 1883, the net revenues were 1,677,818 dols. 51 cents. Including the surplus in hand on January 1st, there is a sum of 5,071,703 dols. 75 cents in hand. Deducting appropriations for dividend of 1¾ per cent., payable April 16th, interest on bonded debt and sinking funds, there remained on April 1st, 1883, a surplus of 3,545,242 dols. 50 cents. The net revenues for the quarter ending June 30th inst., based upon nearly completed returns for April, partial returns for May, and estimating the business for June, will be about 1,725,000 dols. Adding the surplus, April 1st, as above, the total available is 5,270,242 dols. 50 cents. After providing for interest on bonded debt and sinking funds, there remains a balance of 5,143,542 dols. 50 cents; 1,399,750 dols. is required for the payment of a dividend of 1¾ per cent. on the capital stock, which leaves a surplus of 3,743,792 dols. 50 cents. The lease of the lines of the Mutual Union Company took effect February 15th, 1883, but an injunction to restrain its operation was in force for nearly three months, thus preventing the company during that period from securing the benefits of consolidation in the matter of expenses.

The Eastern and South African Telegraph Company.—This company notifies that the coupons due on their five per cent. mortgage debentures will be paid on and after Monday, by Messrs. Barclay, Bevan & Co. Coupons must be left three clear days for examination.

The West Coast of America Telegraph Company.—The coupons due on the debentures of this company will be paid by Messrs. Barclay, Bevan & Company. The coupons must be left three clear days for examination.

The Gülcher Electric Light and Power Company.—The offices of this company have been removed to its works at Battersea Foundry, Wellington Road, Battersea, S.W.

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1882.

4162. "Electric lighting, &c." T. T. SMITH. Dated August 31. 10d. The object of this invention is to facilitate and economise the use of electricity for illuminating purposes, whereby houses and other structures may be lighted in any desired part, while employing only a certain given number of lamps in the house. According to the existing method, supposing a private house to require a total of 100 incandescent or other lamps for its adequate illumination, a charge is made by the company based either on the actual consumption as ascertained by an electrical meter, which is a source of expense and trouble, or upon an average of a certain number of lamps, say, for example, 80, in estimated constant use. In the one case there is the necessity for using a meter of some kind, and in the other the tenant is liable to be charged for more lamps than he uses, or the company to be paid for fewer lamps than are burned. Now by this invention a certain total number of lamps will be supplied and charged for, and that number only will be at the disposal of the tenant; but the electrical fittings and connections will be such as to render the lamps interchangeable and removable at pleasure to any part of the house, without any dangerous or unsightly sockets being left projecting from the walls or other surfaces whence the said lamps have been removed.

4235. "Mounting for filaments in electric incandescent lamps." L. R. BISHOP. Dated September 6. 4d. Relates to a particular method of gripping the ends of the carbon filament by the leading-in wires. (*Provisional Protection not allowed.*)

4845. "Galvano-electric batteries." J. OLIPHANT and E. B. BURR. Dated October 12. 4d. The object of this invention is to make a galvanic or electric battery which causes the electric current to be produced by the decomposition of water without the destruction of the element whose agency causes said decomposition. In an ordinary battery jar is placed a solution of dilute sulphuric acid, in which is placed the zinc element prepared as hereinafter stated. In this jar is placed (advantageously) a porous cell (a porous or other cell not being absolutely necessary), this cell must not be made of any hard substance, but any material unaffected by acids and sufficiently porous may be used, and we find a cell made of asbestos to be very suitable for the purpose. In this cell is placed a carbon of ordinary proportionate size to the cell and to the positive element, and this cell is charged with a solution of nitric acid, water, and bichromate of potash in suitable proportions, this carbon then forms the negative element. The zinc element is prepared by first coating it with mercury in the ordinary way and then coating it with gold, lead, or other suitable metal by either dipping the element in a bath of lead or rolling a sheet of lead upon the mercurialised zinc. After being thus dipped or rolled it is necessary to re-amalgamate the aforesaid element with mercury. By treating the zinc element as previously described, it will be found that the necessary energy will be obtained from this improved battery without the destruction of the positive element as is the case with ordinary batteries. By this means the oxygen evolved from the water will be prevented from forming an oxide of zinc and the battery will be almost constant, an occasional renewal of the acids and water only being necessary.

5001. "Telephonic instruments." G. L. ANDERS. Dated October 20. 6d. Relates to telephonic transmitting and receiving instruments and comprises various improvements, as hereinafter set forth, whereby the inventor increases their sensitiveness, while at the same time he prevents violent vibrations of the contact surfaces and rupture of the circuit in the transmitting instruments and the consequent harshness of sound produced by these instruments when the voice is raised to a high pitch. According to one part of the invention the inventor employs a thin box or chamber, partially or wholly exhausted of air, in place of the diaphragm, tympan, or sounding board heretofore used in certain forms of telephone transmitters as a medium for taking up the vibrations of the air, and conveying them to the microphonic contact surfaces, and he combines the said box or chamber, in some cases, with other parts. By these means he insures great sensitiveness and freedom of vibration and at the same time confines the extent of the vibrations within very narrow limits. These conditions are especially favourable to the use of good conductors, such as the metals for contact surfaces, and the inventor is thus enabled to use for this purpose many materials which have not hitherto been practically available for this purpose on account of the tendency of the contact surfaces to separate so suddenly and completely, under the influence of comparatively slight vibrations of the air, as to make the transmission of speech extremely discontinuous and uncertain. Fig. 1 is a vertical central section of one form of the improved telephone transmitter. Fig. 2 is a plan of the same with the cover removed. In figs. 1 and 2, A represents a circular box of thin metal, hermetically closed and having its upper and lower faces corrugated to increase their elasticity, B, B¹ are bolts fixed in the said upper and lower faces. The bolt, B, is passed through an aperture in the disc or sounding board, C, fixed in the case, D, and the said bolt is secured therein by a washer, *a*, and a pin or cotter, *b*. The bolt, B¹ is passed through an aperture in the case, D, and is adjustable therein by means of the screw nut, *c*. The disc, C, serves as a support for the loose contact piece, E (similiar to that used in the well-known "Reis" transmitter), which is fixed to one end of a rod, E¹, the other end of which is fixed to a block, E², resting by means of two points or pins, *d*, upon suitable bearings provided on the disc, C. This contact piece bears upon the extremity of the bolt, B, which forms the other contact piece or surface. F is a cover secured to the case, D, by screws to protect the said contact-piece, E. The connections are made as shown so that the current passes through the contact pieces, B and E, and the instrument is placed either in direct circuit with a battery and receiving instrument, or in the primary circuit of an induction coil, the secondary circuit being to line. On exhausting the air from the box, A, the upper and lower sides or faces are caused to approach each other by the external pressure of the atmosphere, they are then separated in opposition to the atmospheric pressure by turning the nut, *c*, in the proper direction. The mouthpiece, *e*, leads into an air-space entirely surrounding the vacuum box, so that the vibrations of the air impinge upon the whole surface of the same. The inventor further modifies the invention by constructing transmitting instruments (which may, if desired, be used as receiving instruments), as follows, that is to say, he combines a movable armature and contact piece with a magnet or magnets, and a vibrating diaphragm or armature of magnetic material, and so arranges them that the varying attraction of the magnet upon the said movable armature and contact piece causes a corresponding variation in the pressure between the contact surfaces through which the current passes. In some cases the inventor uses two magnets, i^1, i^2, with poles of different

FIG. 1.

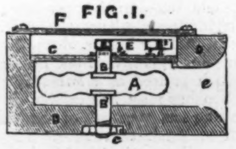


FIG. 2.

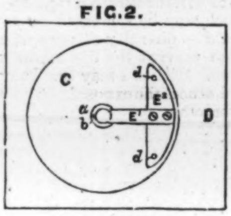
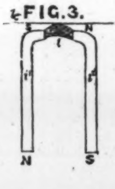


FIG. 3.



name opposite each other, as shown in fig. 3, and places between the two poles a quantity of magnetic conducting material, *l*, such as iron or nickel in a granulated or finely divided condition, the particles being held in place and caused to cling together by magnetic attraction, thus forming a conducting chain extending between the two poles, which are otherwise insulated from each other; the current is passed through this chain of magnetic particles. A diaphragm or armature, *k*, of magnetic material is arranged in front of the poles, the vibrations of which diaphragm cause the particles of the chain to adhere with varying force or pressure. This form or modification of the invention may be varied by using a single pole, placed opposite to a block of magnetic material, and arranging the granulated or finely divided material between the pole and the said block instead of between the two poles, the other parts being as above described.

5060. "Machines employed in the production, collection, and utilisation of electric and magnetic currents or forces." J. S. Fairfax. Dated October 24. 10d. This invention relates to: 1st. The general arrangement and construction of machines for producing and utilising electric and magnetic forces, as electro-magnets and magneto-electric machines. 2nd. The formation or construction of magnets suited to the requirements of the above machines and also adapted for telegraphic, telephonic and other instruments and apparatus. Permanent and electro-magnets are frequently constructed of thin plates, small bars, rods, and wires, because they are found more powerful and act more quickly than solid ones of equal size. By this invention the principle of sub-division is carried to the utmost possible extent by making use of iron and steel dust in the construction of magnets and armatures, the dust being formed by the pulverising of iron and steel borings, turnings or shavings.

5078. "Secondary batteries, &c." A. F. Hills. Dated October 24. 2d. Now the object of this invention is to obtain in secondary batteries the greatest amount of surface contact, and thereby increased capacity for storing electrical energy, at the same time avoiding the inconvenience of the local action. To this end the inventor employs in making the improved batteries oxide of lead in powder. This oxide presents the lead, not only in the highest state of subdivision, but also already oxidised or in the best possible chemical condition for the purpose required. (*Provisional only.*)

5109. "Magnetic brushes for the cure of nervous ailments." E. Parr and J. R. Gibson. Dated October 27. 6d. The object of this invention is to provide by a novel arrangement means by which a magnetic field available for curative purposes may, by the aid of brushes, be introduced into proximity with the skin; as brushes for the flesh, hair, nails, teeth, and for horses, dogs, cattle, sheep, and other animals. In carrying out this invention, the inventors employ steel wire magnetised, which is used as a substitute either entirely or in part for bristles or brushes may be made of bristles with the magnetised wire penetrating the "beds" of the brushes, either slightly projecting therefrom or flush therewith. In either case each and every penetrating wire will constitute a "pole" of a permanent magnet the power of which may be increased by interweaving with the embedded ends thereof a quantity of magnetised steel wire, which arrangement will also prevent the displacement of the penetrating bristles wire or wire and bristles as the case may be. To protect them from atmospheric and other influences the exposed wire may be coated with gold, nickel, aluminium, or other metal. The brushes may be made of any required shape and of any suitable substance, material, or compound, either plain, carved, embossed or moulded according to the various purposes for which they may be required. The steel wire may be magnetised by any known means: by a dynamo or any other machine or arrangement by which a magnetic field may be induced; by preference, we cause it to be "drawn" at the time of manufacture or afterwards, through, over, or otherwise in proximity with the poles of permanent or electro-magnet or magnets, which may be arranged in the form of a "die" or "dies."

5142. "Electric lamps." W. R. Lake. Dated October 28. 4d. (A communication from abroad by B. Egger, of Vienna.) The chief object of this invention is to provide an improved electric lamp or lighting apparatus which shall have all the advantages of a good regulator lamp, that is to say, in which the arc will be automatically formed when a current flows through the lamp and will be maintained at the same length, and which can be used with any number of lamps of similar construction in the same circuit without being disturbed by them. The latter quality is possessed by all lamps constructed upon the well-known differential principle; and the peculiar features of the improved lamp or lighting apparatus consist in the construction and combination of the parts. (*Provisional only.*)

5146. "Telephonic apparatus." J. G. Lorrain. Dated October 30. 4d. Relates to improvements in electric telephonic apparatus whereby a vibrating plate of magnetic material or substance capable of inductive action as usually employed may be dispensed with whilst at the same time instruments of great simplicity and efficiency are obtained. In carrying the said invention into practice the inventor passes a current of electricity through two or more movable and adjacent parts of a continuous conductor and by causing the parts of the said conductor to approach or recede from each other, as for example when connected with a diaphragm or other similar device capable of vibrating freely, an undulation or variation in the strength of the current is produced due to the action of the current upon itself, and if the undulatory current thus produced be sent through two or more movable and adjacent parts of another conductor the said current will cause an attractive or repulsive action to take place between the said movable and adjacent parts of the conductor, which action may be used to set in vibration a diaphragm or similar device placed in mechanical connection therewith. (*Provisional only.*)

5148. "Organs of dynamo, magneto, or electromotive machines, &c." B. J. B. Mills. Dated October 30. 4d. (Communicated from abroad by T. Chutaux, of Paris.) Consists of a new arrangement applied to the principal organs ordinarily used in the construction of electro-motors, dynamo or magneto, employed, for power or light, and other electrical apparatus. The organs referred to are called magnets, electro-magnets and amatures fixed or movable according to requirements. These organs are constructed as is well known, of steel either tempered or not tempered, or of iron or cast iron, magnetised or not, according to their applications. They are of various forms and dimensions and of different sizes according to the requirements of construction. The magnetic and dynamic effects produced by means of these organs are generally more appreciable at the extremities of their poles, south and north, and that under conditions of limited extent of surfaces in presence which only attain the maximum effect with slowness, and cannot even attain it, if the apparatus is compelled to make very rapid rotary or other movements, and in either case, retain remanent and coercive influence, contrary to the result required to be attained. This consequence arises from the fact that the organs which communicate or which receive the magnetic influence only communicate or receive it superficially without penetration into their mass. That being a matter well known, it was necessary, therefore, to discover means to augment the polar surfaces and to assist the penetration of the effect into the mass of the organs, either in their entire dimensions or only at the polar part. This is effected by causing certain channelled, angular or other shaped parts of coacting organs to enter considerably into each other, by overlapping and interfitting or interpenetrating. That is the problem solved by the present invention. (*Provisional only.*)

5149. "Increasing the conductibility of and insulating round or flat cables, &c." B. J. B. Mills. (A communication from abroad by T. Chutaux, of Paris.) Dated October 30. 2d. The present invention consists in giving to the conductors ordinarily employed in the construction of electrical apparatus a conducting value approaching most nearly to that of solid silver without being obliged to incur the cost of the latter. It being granted, and a matter of notoriety, that it is not the mass represented by the body of an electric conductor which offers conductibility for the passage of the current, but it is the exterior surface, the inventor has had the idea, in view of the result of electric conductibility to be obtained, to take the copper conductors of commerce and cover them by any suitable means with a coating of silver relatively thin, to render them of a high conductibility superior to that of chemically pure copper, and in certain cases capable even of surpassing that of the silver of commerce which contains an alloy of copper. In addition to these advantages it has that of having the same conducting value in all parts of a length of wire!!!!!! (*Provisional only.*)

5166. "Circuits for telephonic communication." H. Alabaster and T. E. Gatehouse. Dated October 30. 6d. Relates to the arrangement of circuits for telephonic communication where an induction coil and induced currents are used, and is designed to improve the clearness and loudness of articulated messages or other sounds. The inventors find that greatly improved results in clearness and loudness can be obtained by placing the telephone receiver in a local circuit, which usually includes the transmitter and a suitable battery, and which forms the primary wire of the induction coil. The secondary wire thus forms part of the line-wire without direct communication with either transmitter or telephone receiver, and is put to earth at each end.

5167. "Telephonic receivers." H. Alabaster and T. E. Gatehouse. Dated October 30. 6d. Relates to improvements in the construction of telephonic receivers as patented under date June 7th, 1882, and numbered 2675; also to the method of preparation of a part thereof, and has for its object the loud and better communication of articulated or other sounds. Instead of stretching an iron or steel wire surrounded by a coil or coils between two vibrating plates, the inventors use a wire core, surrounded by a coil as before, either attached at one or both ends to rigid supports in the case, or suspended therein, but in no case with the ends attached to vibrating discs. At or about the centre of the steel or iron core thus fixed is attached a wire or thin rod of any sound-conducting material, preferably projecting at right angles to it. At the end of this wire or rod is attached the vibrating plate. The inventors stretch the wire or core under longitudinal strain by any convenient tool or appliance until a permanent set of elongation and a consequent change of molecular structure has taken place.

PROCEEDINGS OF SOCIETIES.

Physical Society.—June 23.

Professor Clifton in the Chair.

New member, Mr. Stearn.

Professor D. E. Hughes, F.R.S., exhibited a number of experiments illustrating his theory that a magnet is made up of magnetic molecules, each of which is a small magnet. When a magnetic metal is in a neutral state he showed that there is a symmetrical arrangement of the molecules, such as to make them satisfy their mutual attractions; not, as on Ampère's theory, a "higgledy-piggledy" arrangement.

Professor Guthrie stated that a piece of watch-spring magnetised retains its magnetism when impregnated with mercury.

Professor Everett, Mr. W. H. Coffin, and others, remaked that Ampère's theory tried to account for the magnetism of the molecules.

Professors Perry and Ayrton observed that when soft iron is between red and white hot it ceases to be attracted by a magnet.

The new absolute sine galvanometer* of Professor Minchin was then exhibited to the meeting by Professor S. Carey Foster. It is intended for the Cornell University, and measures less than the E.M.F. of a Daniell cell. The principle of the instrument was described at a former meeting of the society.

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* See Electrical Review for May 26th, 1883.

Professor **Ayrton**, Lord **Rayleigh**, Mr. **Coffin**, and Professor **Clifton** offered some remarks on the apparatus.

A "Note on the induction balance effect and the densities of alloys of copper and antimony," by Mr. George Kamensky, A.R.S.M., was then explained by Professor **Chandler Roberts**. These experiments were to determine whether the curve of the electrical resistance of the copper antimony alloys would be a straight horizontal line, ∪-shaped or of the ∟ type. They were found to belong to the last type.

It is seen from the curve exhibited that there is a rapid fall from copper to the alloy containing only 10 per cent. antimony, and this decrement is continued until the alloy St Cu_4 is reached, when the curve turns rapidly and rises to St Cu_2, then turns again and passes to pure antimony. Professor Roberts has shown that the alloy Sn Cu_4 occupies the lowest point of the curve, namely, the position that in the copper-antimony series is occupied by the alloy St Cu_4. In the copper-tin series the second critical point is held by Sn Cu_3, and in the copper-antimony curve this point is held not by Cu_3 Sb, but Cu_2 Sb, the formula for the violet alloy known to alchemists as the "regulus of Venus." The specific gravities were also plotted in curves, showing that the alloy Cu_2 Sb does not stand out from the rest, while the alloy Cu_4 Sb has a higher density than copper.

TO CORRESPONDENTS.

No notice can be taken of anonymous communications. Whatever is intended for insertion must be authenticated by the name and address of the writer, not necessarily for publication, but as a guarantee of good faith.

Letters, &c., for the "Correspondence" columns should arrive not later than Tuesday morning if they are desired to appear in the following number, such communications to be addressed to the "Editors," Electrical Review, 22, Paternoster Row, London, E.C.

Letters respecting Advertisements, Subscriptions, &c., should be sent to the "Publisher," Electrical Review, at above address.

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CORRESPONDENCE.

On the Winding of Electro-Magnets.

Professors Ayrton and Perry, having directed their experiments towards the discovery of the best mode of winding a given length of wire on an iron bar to give the strongest electro-magnet for the same current, have just supplied me with part of the information of which I have been in search. We pigmies in electrical erudition are apt to take it for granted that the giants (such as the above-mentioned professors) have already discovered and are familiar with all the laws and rules which should govern electricians in the most advantageous construction of instruments, and sometimes we suppose that it is only due to our own comparative ignorance that we are unacquainted with these rules.

Curious to say, I had noted with other plans of winding electro-magnets, those mentioned by Professors Ayrton and Perry in *Phil. Mag.* for this month, or rather I had noted the desirability of investigating the respective effects of winding, so as to give the electro-magnet the form (nearly) of (*i*) an hour glass and (*ii*) of an egg. Something in the construction of some noted induction coils led me to believe that this question had already been investigated, but as I could not find any published account of the laws regulating these effects, I was anxious to find them out for myself.

I am also desirous of investigating the effect of winding in another manner, which appears advantageous.

Suppose that the reel of an electro-magnet will hold 40 turns of wire of a particular gauge in each layer. I propose, instead of winding one wire 40 times in each layer, to take 40 wires and wind them side by side until the reel is full, bringing out the 40 inside ends through a slit in the core. It is obvious that the eighty ends may be joined up in many ways so as to vary the resistance of the electro-magnet, and if the 40 wires are joined up in parallel circuit the resistance will be enormously reduced. For example, a coil, which wound in the ordinary way has a resistance of 400 ohms, may be wound so as to have 40 parallel circuits of 10 ohms each and (following the law that the joint resistance of any number of wires joined parallel to one another is equal to the reciprocal of the sum of the reciprocals of their respective resistances) their joint resistance will be only ·25 ohms instead of 400 as when connected in series, whereas the current passing through any one of them will be the same as in series. As the current passing through any turn of wire in the coil will be the same in both cases, I conclude that the magnetic effect will also be the same, whereas the total resistance of the coil may be enormously reduced.

As the resistance of an electro-magnet should always bear a certain proportion to the total resistance in circuit in order to obtain the maximum effect, it would appear that the above means of varying the resistance of the electro-magnet for the various resistances of different circuits may be applied with good effect. In telegraph instruments, Mr. R. Sabine has shown that the speed of transmission diminishes with the resistance in circuit, and that the resistance of the receiving instrument has a great influence on the speed, so that it would seem that this plan of reducing resistance might be adopted with advantage, especially where there are a number of electro-magnets in circuit. I propose also to try the effect of variation in gauge of the wires near the poles and towards the neutral line of the magnet. This mode of winding in fact will suggest an endless variety of combinations in joining up the wires, so that the resistance may be varied within a very wide range, to say nothing of differential and partly differential methods. I write this with some diffidence, as I may have made some gigantic error in principle, so I shall only sign myself,

Cacarucas.

I enclose my card.

[Our correspondent has not advanced anything new in his letter, for we have often seen and used electro-magnets wound as he suggests. Such a method of winding might possibly be conveniently used in certain cases; but it would be rather awkward from several points of view to have a great many ends of wire sticking about.—Eds. Elec. Rev.]

Secondary Generators.

I observe Mr. Pickering's remarks in regard to the conclusions to be drawn from the experiments shortly described by me. These experiments were made by me long before I heard of Gaulard and Gibbs' induction apparatus, and I have not yet met with an instance in which the effects of the *secondary current* in *increasing* the primary current was pointed out publicly previously to my letter.

Mr. Pickering apparently does not grasp the full teaching of the experiments which I described; he says Messrs. Gaulard and Gibbs came to the conclusion "That the movement of the current in the primary generated a current in the thin wire of the secondary"—this same conclusion was come to by Faraday, Rhumkorff, and others, many years ago, I believe. Then "that this secondary current being necessarily generated in an opposite direction to the primary current, acted solely and simply as a resistance to the primary current"—we need not mind the rest of the sentences in between the commas, but how one current can act solely and simply as a *resistance* to another current is more than I can understand, and besides, if the secondary current resists the primary, why is the current in the primary so vastly *greater* when the secondary current is closed? Mr. Pickering does not at all touch the points raised by my experiments; he again says, if I had not used a large electro-magnet but had used one with only one layer of wire I would not have found the same amount of decrease in an alternate current passed through. He is right there in all respects. I am, and hope every one calling himself an electrician is, aware that magnetic and induction effects are very much influenced in their intensity by the lenth of wires used in their production, and he will find that a counter-F.M.F is set up in any wire wound on iron and through which alternating currents are passed whether that wire makes one turn round the iron or 1,000 turns; however, this action is not the most important one exhibited by my experiments, although it is very interesting and not to be explained by the off-hand crude theory set forth in Mr. Pickering's letter.

Then again I venture to assert that the current or "quantity of primary current" *is affected* by passing through an induction coil, and this is the important point in my experiments. *The primary current increases as the resistance in the secondary circuit decreases* or, in other words, *the primary E.M.F. increases as the current in the secondary circuit increases.*

I think I have shown very clearly that secondary generators cannot be worked in series; in secondary generators

$$\mathrm{C} = \frac{\mathrm{E} - e}{\mathrm{R}} \qquad \text{or} \qquad \mathrm{C} = \frac{\mathrm{E}}{\mathrm{R} + r}$$

if we call the cause of the decrease of current due to the iron core a resistance "r" would be in ohms. But the cause of the decrease in the primary current when the iron core is introduced is due to counter-E.M.F., and should be written "$-e$."

Then as to the increase of E.M.F. in the primary circuit when the secondary circuit is closed, the cause of this is evidently not a decrease of resistance in the primary circuit, but an effect of the secondary current which sets up a "$+E$" acting with and added to the E.M.F. of the primary circuit, hence when the generator is in action and the secondary circuit closed the primary current "C" is equal to

$$C = \frac{E - e + e}{R}$$

with the primary current, going through the primary wire, no core inserted, and the secondary open

$$C = \frac{E}{R}$$

With core in secondary open

$$C = \frac{E - e}{R}$$

With core in secondary closed

$$C = \frac{E - e + e}{R}$$

These three formulæ apply to all induction coils or other induction apparatus, along with other formulæ relating to the inductive action of the currents reacting upon themselves, which need not be noticed here as their action is very small.

This $-e$ and $+e$ may be treated as resistances of course, although they are not resistances, and the three formulæ written

$$C = \frac{E}{R} \qquad C = \frac{E}{R + r} \qquad C \quad \frac{E}{R + r - r}$$

It would be more satisfactory if correspondents who profess to be certain of the nature of phenomena resulting from actions of secondary generators were to give a clear exposition of them, and describe some of their many experiments, than merely to copy superficial opinions from newspaper science, in which the advantages *claimed* are fully set forth, but in which nothing set forth gives the slightest hint as to how the advantages are to be *obtained*.

I have given account of my experiments, and your readers may draw conclusions themselves, and of course can also draw conclusions from the facts advanced in favour of secondary generators as distributors.

I did not mean to carry on a discussion on this subject, but merely intended to describe simple and easily repeated experiments, strikingly proving and exhibiting the apparently little known actions and interactions taking place in secondary generators. The use of Maxim lamps enabled me to exhibit the effects to a large audience in a very striking series of experiments with alternating currents.

Rankin Kennedy,
Electrician.

Tests of Incandescence Electric Lamps.

My attention has been called to the report which appeared in your issue of June 9th, respecting the "new incandescent glow lamps" manufactured by the Universal Electric Light Company, and as a little mistake has been made and wrong impression circulated amongst electric circles as to the actual C.P. lamps we are making, permit me to say your report should have read "from 20 to 50 candle-power," and not 20 to 500, as stated. However, I am pleased to say, Mr. Editor, that we have some 500 candle-power lamps making at the works, which are open for your inspection, or any one else you would like to send for that purpose; but these are not at present offered for sale by us, nor will they be until their lives can be ascertained by actual tests to our satisfaction, which, I am glad to say, can be done without resorting to the jocular mode suggested by you in your remarks upon this subject; I am thankful to say there are other means of testing the life of a lamp without taxing the carbon elements of one's system by carrying out your proposal. So far as my small experience goes, I find it much easier to test my filaments in the open, and all such as will stand the current of a "Gramme" machine for five minutes are pretty safe to close in vacuum and run for 1,500 or 2,000 hours if required. Personally I profess to know but very little about electricity, and the further I search into its mysterious depths the more puzzled I become to find out what it really is; and, so far as my little knowledge goes, I would not venture to say it was *not* the twin brother of music (when one takes into consideration the chords it has on the Stock Exchange), or for aught I know it may be a will o' the wisp or a vampire that may lead us through the lane to the road that may take us to the nearest angle of perpetual motion. I also note that you express a good deal of surprise at our existence, and as you, to a great extent, throw a doubt upon the merits and life of the Universal Lamp, I think it only fair to say it is well known in many circles and looked upon by some of our leading electricians as the lamp of the future; and the results and tests made by one of the leading men of the day respecting three leading numbers manufactured by my company (see particulars), I think will bear comparison with any other maker's lamp in the market. Our company was one of the first formed, but owing to several mushroom companies having taken up installations for nothing, we preferred for them to pave the way, and in the meantime contented ourselves and our shareholders by picking up the small crumbs abroad, out of which we have, by doing only profitable business, managed to pay a dividend of over 15 per cent. for the past three years, and none of our shares, which are in a few hands, are obtainable at any price. As you have promised your numerous readers to give them your own opinion as to our lamps, all I can say is I shall be happy to give you every facility for so doing, except the secret mode adopted by us for extending the life of our lamps, which, we intend to keep to ourselves and save the patent fees charged for protection. I may also say that in addition to the manufacture of lamps our works at the West-end are in full swing manufacturing one or two new inventions in the shape of thermopiles, storage and primary batteries, which at an early date will be introduced by my company with a view to obtain some of the orders which must increase tenfold as time goes on and the demand for electricity, so much required, is placed on a sound and safe footing, in order to meet the requirements of our enlightened age. By inserting this letter in your next issue you will much oblige

Arthur Shippey.

13, King Street, E.C.

Test of 20 *candle-power lamp.*

Lamp.	Volts at Poles of lamp.	Current in ampères.	Resistance of lamps in ohms.	No. of lamps per H.P. Electrical.	No. of candles per H.P. Electrical.	Light in standard candles.	20 candle-power.
A	20·25	2·03	9·97	18·28	67·63	3·7	Cold resistance 19 ohms.
"	24·5	2·65	9·24	11·15	149	12·96	
"	26·75	2·9	9·22	9·7	282·85	29·16	
"	27·5	3·35	8·2	8·1	326·5	40·3	
"	30·5	3·35	9·1	7·34	436·7	59·5	

Test of 30 *candle-power lamp.*

B	22·5	2·13	10·56	15·7	89·5	5·7	Cold resistance 20·2 ohms.
"	25·75	2·4	10·7	12·2	268·4	22	
"	28·75	2·6	11·06	10·4	335	32·3	
"	29·75	2·83	10·51	9·18	477	52	
"	32·5	3·03	10·72	7·6	557	73·3	

Test of 50 *candle-power lamp.*

C.	22·5	1·82	12·36	18·3	126	6·9	Cold resistance 20·3.
"	27·0	2·37	11·39	11·7	308	26·4	
"	28·5	2·55	11·17	10·3	370	36·0	
"	31	2·77	11·19	8·7	517	59·5	
"	32·5	3·03	10·72	7·6	886	116·64	

[In making a few comments on Mr. Shippey's letter we wish to say concerning the candle-power of the lamps mentioned in our note, that the figures 20 to 500 are those given in the communication we received from that gentleman's office, the mistake therefore was not ours. This matter, however, is now set right. Mr. Shippey's original method of calculating the life of an incandescence lamp by sending the full current of the machine through the filament for 5 minutes will no doubt commend itself to our readers who are engaged in such work. Unfortunately, however, he does not state whether he tests them singly or in numbers at a time, and as the external resistance has some influence on the current produced we do not know whether such filaments become luminous "in the open" or not. In the table of tests appended to our correspondent's letter we notice that lamp "A" has a resistance of 8·2 ohms at a luminosity of 40 candles, and 9·1 ohms when raised to 59 candles. The resistance (hot) of lamp "B" also varies in a way which would lead one to believe that the readings of current and electromotive force were not accurately noted, the resistances of course being calculated from C and E. Is it that the filaments of these lamps have a core of platinum? In conclusion, we think that Mr. Shippey will find, if he makes comparisons on the tests of the Swan lamp and several others with that which he represents, that the "Universal" lamp for given luminosities takes a little more horse-power, which indeed one might expect from such a low-resistance lamp.—EDS. ELEC. REV.]

Zinc-Coated Carbon Rods for Electric Lighting.

I have lately been using some carbon rods when testing my arc lamps, coated with zinc instead of copper, with the result that much more light is obtained. The zinc fuses at the top of the positive carbon, and becomes transformed into zinc oxide, this zinc oxide and the carbon become consumed together, emitting an intensely *white* light of greater illuminating power than either the ordinary black carbon rods or those coated with copper. I am quite aware that zinc is a metal of much less conductivity than copper, still it is a much better conductor than carbon. If the formula for making the zincing bath is likely to be of service to your readers, they are welcome to it:—

Neutral zinc sulphate crystallised . .	2 lbs.
Water	1 gallon.

Stir well until the zinc sulphate has dissolved, then filter.

Use a large, clean zinc anode, suspend the carbons to be coated with zinc in the solution precisely the same as for coating them with copper. The above answers well with a series dynamo plating machine or with batteries, but with a *shunt* plating dynamo, one pound and a half of zinc sulphate to the gallon of water works better.

A. J. Jarman.

London, *June* 25*th*, 1883.

Efficiency of Electro-Motors.

In reply to Mr. Heap's inquiry as to the mode employed by us when testing the efficiency of the Griscom motor, we think that in view of the fact that our paper will shortly be published *in extenso* it would be hardly fair to occupy your columns with this part of our paper twice over.

Ayrton and Perry.

London, *June* 25*th*, 1883.

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